Materials & Methods

THE INDUSTRIES' ENGINEERING MAGAZINE

MATERIALS & METHODS Achievement Award Competition

Foamed Cellulose Acetate—A New Plastic

New 9% Nickel Tubing Steel—Properties and Processing

New Strong Aluminum Casting Alloy

A New Method of Spacing for Hole Drilling

Caustic Soda as a Quenching Medium for Steel

New Oxygen-Arc Process for Cutting

A New Process for Bright Copper Plating

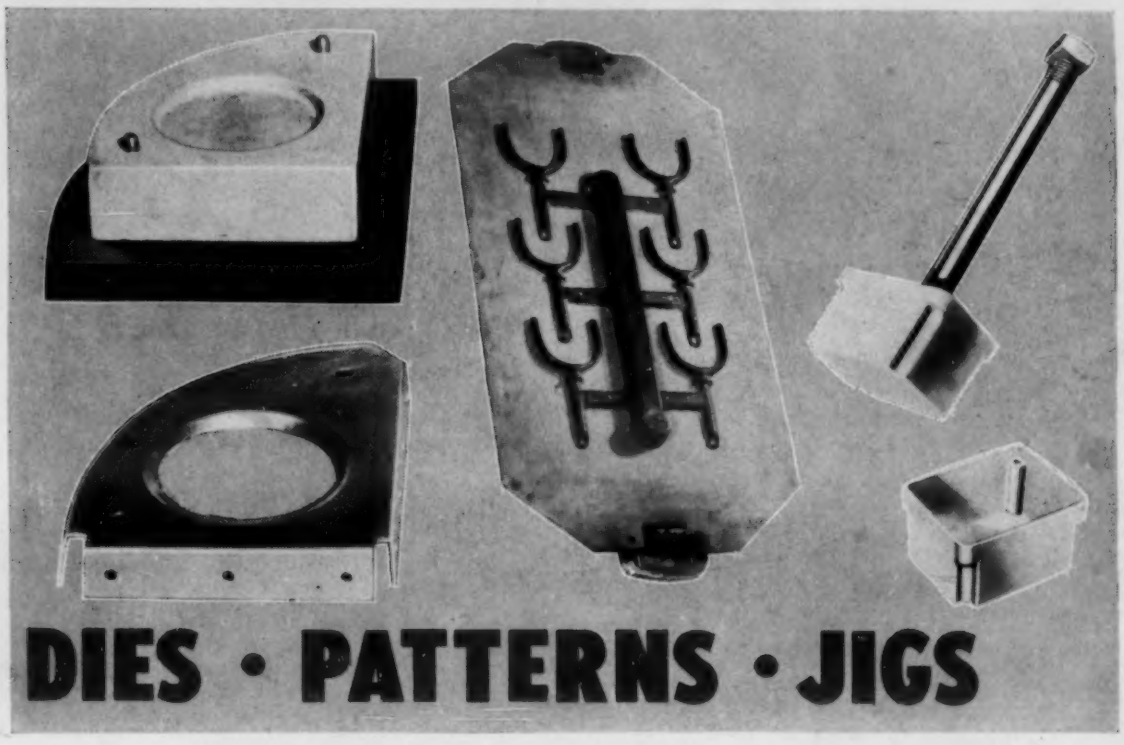
Annual Engineering Review

MATERIALS & METHODS Manual No. 22

January 1947

PUBLISHED SINCE 1929 AS METALS AND ALLOYS

CAST PLASTIC DIES • PATTERNS • JIGS



Typical of the current trend toward making production methods ultra-efficient is the use of Durez casting resin . . . to reduce the time and cost involved in conventional die-, pattern-, and jig-making . . . to speed production.

Cast Plastic Dies

Durez casting resin lends itself readily to cast forms for hydropress operation. The cast plastic die illustrated above left is used regularly under 75 tons press load and has produced hundreds of pieces, similar to the one shown below it, without flaw. Tests have shown it to be capable of withstanding up to 270 tons press load, equivalent to about 12,000 psi.

Cast Plastic Patterns

Alert foundrymen everywhere have been quick to see the production advantages of cast Durez resin patterns such as the match plate illustrated above center. The inexpensive Durez casting resin is simply poured and cured. The perfectly reproduced pattern is then mounted on the plate. The time- and cost-saving benefits are obvious.

Cast Plastic Jigs

The fixture, illustrated above right, for holding die-cast metal covers while a few finishing operations are performed is an excellent example of the simplicity of producing such fixtures with Durez casting resin. It was only necessary to coat the inside of one of the covers with a parting agent and pour in the resin. While the resin was in a semi-viscous state, the stud was located in place. After allowing the assembly to set for a few hours, it was placed in an oven and cured. When taken from the oven, the die-cast cover was removed and the fixture ready for use, the stud being anchored securely in the resin. Long-wearing qualities of the casting resin are excellent.

Characteristics of Casting Resin

Tests have shown that Durez casting resin may be sawed easily, that it drills like hard maple wood, that it will not hold heat or be softened by it, and that it will not ignite. Standard wood- or metal-working equipment may be used. The liquid resin follows the contours of any part exactly and holds them to predetermined tolerances. Its shrinkage factor is but .0025 inches per inch.

Other Uses

A few additional uses for Durez casting resin are stretch-press dies, masking shields for plating, models for testing and duplicating, and checking and assembly fixtures.

Informative Booklet

As specialists in the production of phenolic plastics and resins for almost three decades, Durez technicians have gained an enviable record for developing plastics and resins that fit the job. This background includes molding compounds, industrial and protective coating resins. The benefits which this rich experience can provide are available to you. Write for complete, authoritative folder on casting resin. Durez Plastics & Chemicals, Inc., 91 Walck Road, North Tonawanda, N. Y.

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- MOLDING COMPOUNDS
- INDUSTRIAL RESINS
- OIL SOLUBLE RESINS

PLASTICS THAT FIT THE JOB

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PUBLISHED SINCE 1929 AS METALS AND ALLOYS

IN

1941

METAL POWDERS PRODUCERS
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WILL CONTINUE TO
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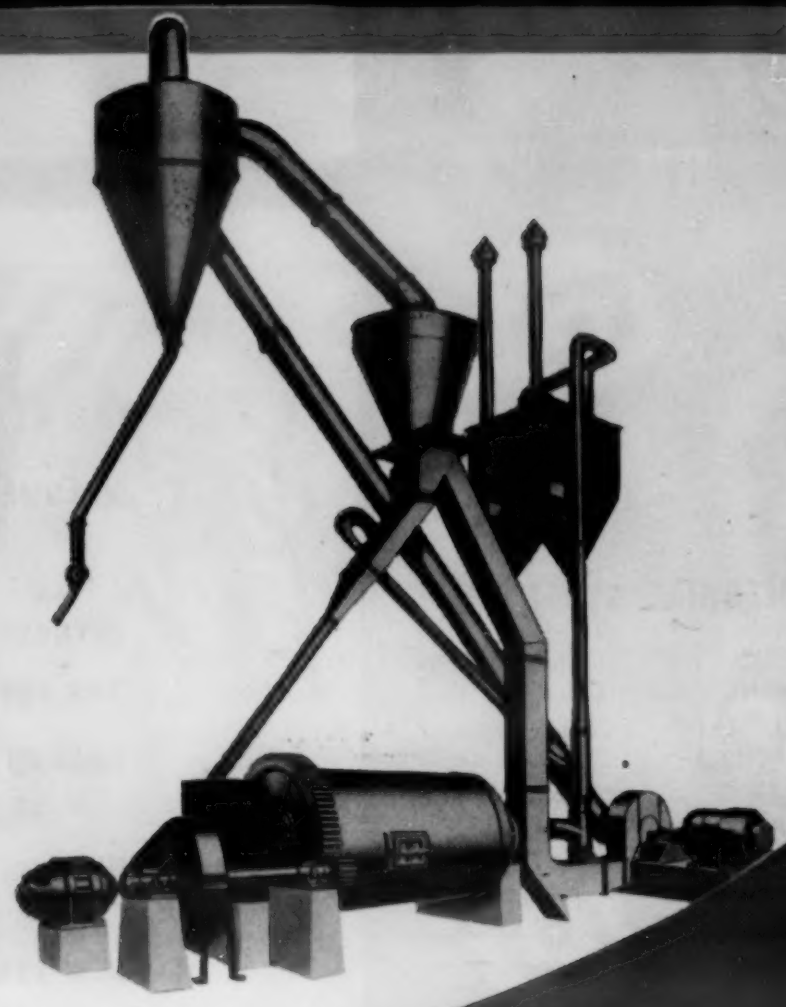

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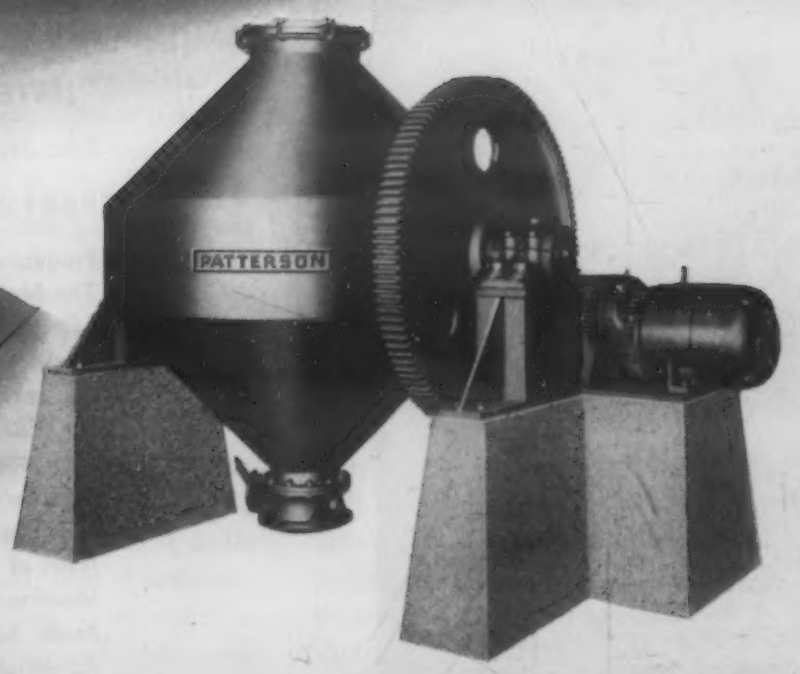

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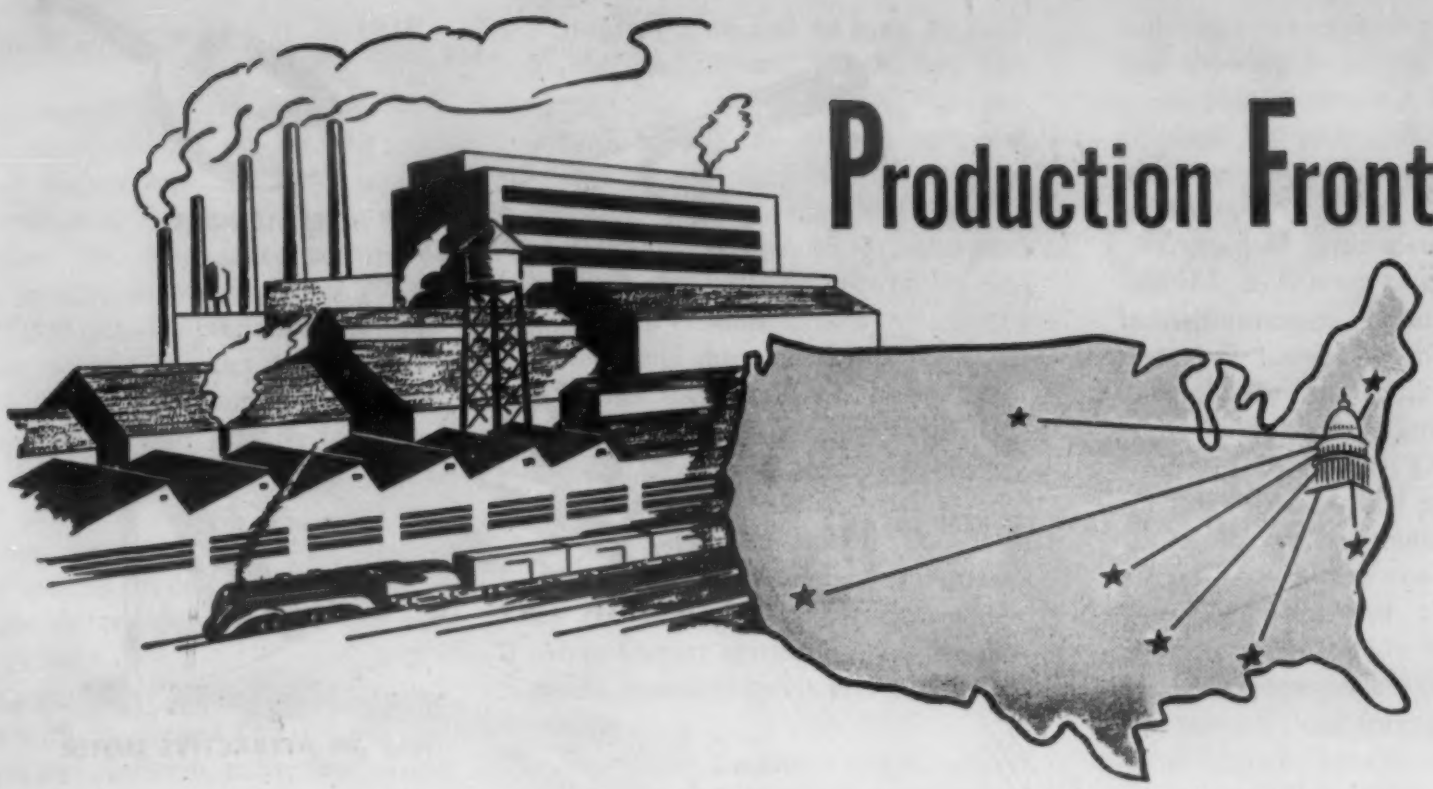


Production Frontiers

"Handwriting on Wall" With Modern Pens

Behold the handwriting on the wall! It is inscribed with a fountain pen that would write under water. Which is perhaps an allegorical way of saying that a fundamental truth dating back to Biblical times is true in stream-lined today, at the beginning of a new year, A.D. 1947.

The wiser elements that have participated actively in this era of U. S. labor unrest and ludricrous cockiness are again beholding that handwriting on the wall—a handwriting that was originally in some foreign tongue, perhaps Arabic, or mayhap even hieroglyphics.

The handwriting in this most recent era was spelled out in early November, as follows: "Election Day Results". Thick-skulled John L. Lewis finally made out the handwriting, handicapped as he is by his shaggy beetled-brows which obscure vision. What perhaps served as a magnifying glass and spot light focused on the handwriting was a fine of $3,500,000 upon his union and a $10,000 billy-due upon his own person.

Then recall Dan Tobin, head of the rough and gruff teamsters' union—he who sprang into the limelight at the "Battle of the Hotel Statler" after the late President's homely campaign speech. Says Tobin, the teamster: "Strikes must be curtailed or the nation will sink into chaos and organized labor will perish". And he says that not merely in the ethereal waves of speech but in the coldness of type in the teamsters' official organ.

In speaking of wildcat strikes, "Dear Dan" said: "This union did not reach its present position of power and influence by letting screwballs run wild. Its oldtime members (AFL) did not fight and starve to create an organization for others to tear apart. The strike is a weapon of last resort to be used only after every peaceful method of settlement has been tried and has failed."

History of Our Productivity

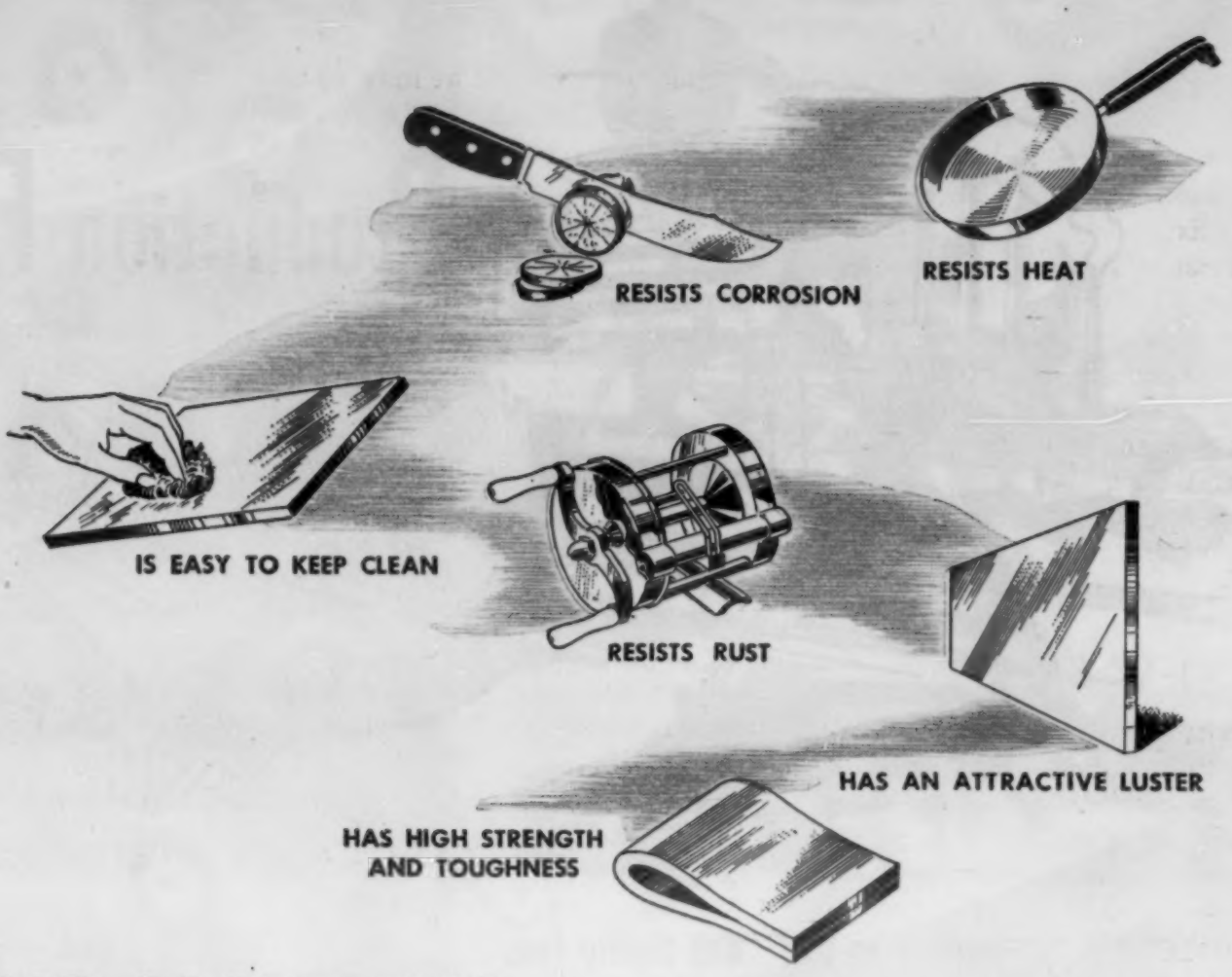
And, speaking of wildcat strikes, F. D. Newbury, vice president, Westinghouse, stated recently that one of the larger automobile companies reported to the press 50 unauthorized strikes in its own plants between June 6 and Aug. 21, 1946. Here are some other thought-provoking statements: "Labor has been granted a sizable advance payment against future increases in production per man-hour. Unit costs in American manufacturing have been rising since 1933, the trend accelerating since 1941 and again since the autumn of 1945.

"Output per man-hour more than tripled from 1899 to 1939, or at a rate of 3% per year, compounded; from 1919 to 1939 productivity increased at the highest rate in our history, or 4¼% per year, compounded. Yet for 1899 to 1939, when agriculture, trade and manufacturing are grouped, the increase annually has been only 2%—a very narrow margin of safety between growth and decline of our standard of living. The entire gain in productivity of all manufacturing over this 40 years went into higher wages," stated Mr. Newbury.

"One of the reasons the American workman is so well off is this. In 1939 the daily horsepower of mechanical energy available per capita was 11.9 in the United States, 7.6 in Great Britain and 1.9 in Russia. The American can thus earn one day's food for his family by 1.6 hours of labor as against 10 hours for the Russian.

"We are now witnessing a hare and tortoise race in which the tortoise, productivity, has little chance. Productivity doubles in 20 years, but hourly wage rates nearly doubled between 1939 and 1946. The unions, the Government and the idealists have been too impatient."

In speaking of the present state of the nation, John D. Small, on the eve of his retirement from head of the Civilian Production Administration, and commenting on the state of prosperity and prospects for a depression, asked: "How can we have a set-back in prosperity with 58,000,000 persons working? And with people so hungry for so many goods?" The official November report of CPA states, too, that industrial activity increased moderately in October to a new postwar high. The gain was mostly in textile products and manufactured foodstuffs.



SUPERIOR PROPERTIES

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If you are interested in the newer uses of stainless and other alloy steels, ask to receive the monthly publication, ELECTROMET REVIEW. Or, if you need advice on their production, properties, or fabrication, write our Technical Service Department. We do not make steel, but we do produce the ferro-alloys which are used in its manufacture, and our engineers have accumulated a fund of information on the use of stainless steel in many industries.

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BEAUTIFUL ENDURING STRONG TOUGH

The Metal Exposition II — 1946

Fewer exhibits and comparatively light attendance set off the National Metal Exposition and four-society convention at Atlantic City the week of Nov. 18. Attendance seemed at least smaller than the touted 20,000 to 25,000 persons predicted. In mitigation, some remarked that an exposition at an off-the-main-line center brings out the ones actually interested and not the sightseers, kibitzers and pick pockets. Absent from the exhibitors were several of the largest steel makers, J. & L. ranking first as to size of companies when the roll was called.

International Nickel had the glory spot with its alleged $35,000 exhibit, up on the platform, main floor, using their priority space with most telling effect, even to the purple sawdust on the floor. A half day in that one booth would not have been wasted. The General Electric booth probably took the most square footage. According to reports, Westinghouse arrived with their goods, encountered labor troubles and went back home. In several booths were signs: "Reserved for ———", but reservations were not fulfilled.

Now a word about Atlantic City. Remember getting that postcard reading: "Here for a change and rest. The bellboys got all my change; the hotel cashier, the rest"? Remember, too, the gags about the "Hotel Paymore" (Traymore) and "Marlborough-Bleedem" (Blenheim). Having been primed, the shock was not severe. There were dire rumors that, to finance a new boardwalk, there was a $2 per bottle corkage fee for tonics taken into bedrooms, but we found the rumors groundless, at least as to our own tonic-loving friends.

The boardwalk itself seemed to be of mid-summer occupancy proportions. The various outdoor solariums, with their reclining deck chairs and blankets were well occupied. The balmy weather made one wonder whether the gulf stream had shifted. Some watched the 4 o'clock pulling of the deep-sea seine with its odd variety of fish. Some rode in the military amphibious duck, provided by H. H. Harris of General Alloys. We recalled our previous visit four years ago when convoys of perhaps two dozen ships were protected by blimps against submarines, with boardwalk lights greatly shaded.

But it is noon and we must go back to the auditorium, which has just opened for the exhibits. We can merely scratch the surface here and —speaking of scratch—that was interesting stuff, "Liquid Envelope," a plastic which is put on stainless steel sheet at the mills on request so that when the customer draws or stamps it the steel does not have the usual scratches and blemishes. Better Coatings & Finishes, Inc., Newark, have an idea there. General Electric displayed a new pneumatic fatigue testing machine that tests materials at their natural frequencies and speeds up the testing. Interesting, was the Arcos Oxyarc cutting process for alloy steels, stainless steels and nonferrous metals.

A color photomicrograph, 26 in. in dia., probably the largest natural color photomicrographic transparency ever made, was exhibited for the first time by Eastman Kodak Co. It is a five-time enlargement from an original color transparency of gray cast iron showing large graphite flakes in a pearlitic structure. It was photographed by polarized light with a sensitive tint plate at 1800 magnifications.

Tocco had a novel trigger or heat gun that moves up to the work to be induction-heated, rather than having the work moved to the machine. It does the heating without the usual cumbersome coils. Here was a chance for a little horseplay, a variation from the "hot foot," called in this case the "hot coin" or "hot pants." A so-called friend moves the machine up and focuses it on your change pocket. Your money literally begins to burn holes in your pocket.

Then let's not forget the little gew gaws, knick knacks and souvenirs passed out, such as the usual calendars and matches, augmented by the perennial large envelopes for carrying literature, ash trays, plastic coated bolts, metal identification cards (with

"—then add a jigger of rye and stir!"

"SharonSharp" KN-44*

YEARS of scientific research in cutting steels form a background for "SharonSharp", an unusually high grade stainless cutlery steel.

Metallurgically controlled to assure the exact content of carbon, chromium and other essential components, "SharonSharp" provides a superior hard cutting edge that retains sharpness longer without impairing stain-resistant qualities.

"SharonSharp" is air hardening, eliminating the work of oil quenching. It also reduces straightening costs.

For the answer to your problem in stainless steel, consult Sharon today.

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name, social security number, etc. engraved while you waited). Also the plastic belts dielectrically sealed to buckles; also the plastic-coated matches, taken out of water-filled goldfish bowls and lighted (good for hunters and fishermen). The technical sessions were well attended, one such drawing at least 1000.

We had our own little side show, the dinner Wednesday night to the winners and judges of the annual MATERIALS & METHODS Achievements award, and several distinguished guests, some three dozen in attendance—a chummy and mellow little group!

Well, so long until the next "show" at Chicago in October, 1947 and—to whom it may concern—that affair better be better!

More Nonferrous Metal Powder, Too

In this department for October, on page 815, we described in glowing terms plans for an iron powder plant in Minnesota which would expand production of that material by 5 tons per day. Now even more noteworthy production expansions in the nonferrous metal powder field are underway, to be completed in mid 1947.

The U. S. Metals Refining Co., a subsidiary of American Metal Co., Ltd., in Carteret, N. J., is one of the country's largest smelters and refiners of copper, lead and precious metals, also producers of solder and aluminum ingot. For some years they have been doing what the iron powder people would call an enormous business in nonferrous metal powders—350-400 tons per month of copper, 50 tons of lead and (in the past year) 50 tons of special copper-lead powder. (About 12 to 15 tons per day of copper powder alone, for example.)

We experienced a personally conducted tour of the entire Carteret plant. They showed us how the electrolytic copper "mud," produced in a special section of the electrolytic refinery, is reduced (to clean the particle surfaces), milled, classified, and blended to match customers' specifications in 5,000- to 25,000-lb. blending machines, to give a clean, closely controlled, excellent-molding electrolytic copper powder; how a special copper-lead powder, superlative for special-purpose bearings, is melted in high-temperature gas furnaces and poured hot through a blast of high-pressure water; and how gold and silver and such rare powders as those of platinum, osmium, iridium, etc. are "babied" through step after step to their final ingot or powder form.

The new construction to take care of the expansion in powder-producing capacity, like all new construction today, is proceeding slowly. When it is completed later this year, U. S. Metals Refining Co. will have a total copper powder producing capacity of 1.5 million lb. per month (about 25 tons per day) and a capacity for tin and solder powders of 100,000 lb. per month each. And when we remind ourselves that this is just one of the plants making copper powder and that its copper powder capacity right now (12 to 15 tons per day) is about double that of the entire iron powder producing industry, we begin to get a sense of proportion concerning ferrous and nonferrous powder metallurgy.

The specialty products (bearings, brushes, friction materials, etc.) into which most of the copper powder output goes are still the heavily dominant markets for powder metallurgy. The competitive-parts field, in which iron powder has been largely applied, still has a hard row to hoe before it alone can justify an iron powder output comparable to that of copper powder. Of course, there are hints that the forthcoming expansions in iron powder production are to supply markets other than powder metallurgy fabrication. If this is so, look for a merry battle for position, but keep your money on copper powder as production leader for a long time to come.

We Welcome the Corn Cob

Trying to keep abreast of the fascinating field of materials and methods, we came across an article, "The Corncob Achieves Industrial Status," in the November issue of *Corn* (not to be mistaken for the title of this department). After pointing out how the corn cob can be used as fuel, with BTU value of 7,980 per ton vs. 13,000 for coal, and commenting on its homely original use in competition with mail order catalogs and feed advertising circulars, it mentions an important use by the Navy. The Naval Air Station at Norfolk was supplied with 1,000,000 lb. of soft grit made from the flinty portion of the corn cob.

Used in air blast equipment, it scoured away grease and carbon without damage to the polished surface of pistons, cylinder walls and bearings. A mixture of cob grit with 40% rice hulls proved best. This recalls our visit to the Army Air Forces engine overhaul plant at Wright Field, Dayton, where they use soft nut shells (presumably almonds) for the same sort of work.

The synthetic rubber program owed much of its success to the production of furfural from corn cobs, the furfural being a "crackajack" solvent for isolating butadiene from undesired products.

Indeed, we welcome corn cobs into our field of "Materials and Methods" and would like to see the cob properly honored in our 1947 Achievement Award.

Good Old "Zircon"!

For over a century zirconium has been classified as a "rare metal" in the chemistry textbooks, but actually, in view of some two dozen common uses and as many more uncommon uses today, it is rare only that it starts with a "Z".

It is one of the 20 most abundant elements on the earth's surface. Many textbooks dismiss it in a few lines, implying non-importance; some textbooks do not mention it in the index. But it is proving a very versatile and modern metal, one interesting application being in making a new superior magnesium alloy.

Zirconium alloys serve as scavengers of impurities in molten steel, as an element in certain copper alloys. It is used in radio tubes; in spinnerets which form fibres in rayon mills, states the Rohm & Haas *Reporter* for October. Carloads of its oxide are used in making refractories and in opacifiers for porcelain enamel, as it is inert to nearly all reagents and does not become fluid below 4710 F.

A basic zirconium sulfate tans leather. Other compounds are used in welding rod flux coatings. The oxide was first used as an opacifier for porcelain enamels during War I when tin oxides were cut off. It can replace scarce tin oxide now in "putty powders" for polishing fine glass lenses. It is useful in making molds for precision castings, for high grade crucibles and other laboratory refractory ware standing high temperatures or corrosive atmospheres. Pyrometer tubes of stabilized zirconium oxide do not break down in alkalis and do not devitrify.

The MATERIALS OUTLOOK...

Steel to Continue "Hard-to-Get"

With steel operations dipping to 60% from around 90% at pre-strike, figure delivery dates for your steel one month postponed because of the strike. All along steel makers have been more optimistic over early balancing of supply with demand than have been Government agencies such as CPA, some Washington experts figuring steel shortages throughout 1947. Steel makers were too optimistic over ability to supply plenty in 1940-41 and may again be too optimistic. The closer the product is to pig iron — say castings — the less chance for early and complete delivery. The campaign to get out the scrap bears fruit, for surplus shipyards are breaking up obsolete ships. Steel sheets are very difficult. Previously scarce nails are helped by the Government premium of $20 per ton over an established quota.

Steel Prices Virtually Stable

Steel will continue one of the cheapest basic commodities. The net change over three months will be a very slight rise to better align prices with costs, though makers will absorb some higher costs. Look for some reductions in prices during this lining up process. No need for you buyers to "take a position" on steel, but rather buy as you need.

Worries Over Copper Subsiding

Copper, now at 19½c, as against the war ceiling of 12c, might go to 21½c within the next few weeks because of a traditional trend to get "all the traffic will bear." But higher prices would be short-lived and a price of 15c by mid-year would not be too surprising. The supply situation improves markedly, domestic refined output gaining 15% in October, following an up of 14% in September. The use of substitute metals such as aluminum (unchanged in price from war time) and heavy imports, attracted by the higher price, will take much burden off the red metal. It is quite probable that the 4c import duty will be removed or lessened, also helping the supply.

Aluminum Shortage This Winter?

Well, not a very serious one. Yet there is a shortage of soda ash, used in its manufacture. However, the Government is very aluminum-conscious and will "borrow" metal from Canada that had been earmarked for shipment to Britain. Though prices of aluminum scrap will continue to rise slightly for a time, this will be offset by greater recovery from obsolete aircraft and other items. We have learned better how to prepare our scrap and put to use aluminum of doubtful analysis.

Lead and Zinc

The new lead price of 12.55c will do much to increase supply, and the situation will verge on abundance by mid-year. The higher price here will attract much Mexican lead, while Australia, which shipped us none in 1946, will send considerable in 1947. Substitutes have been developed during the shortage, such as plastics and aluminum for cable-sheathing, despite disputes as to efficiency of substitutes. Our own lead mines, working five days per week, will step up to six. Zinc, at 10½c, is at its peak since higher prices would encourage large scale substitutions. Thus, even at previous low zinc prices galvanized sheets met stiff competition from aluminum sheets made from scrap for roofing. The automobile makers may easily abandon zinc die castings and extrusions and turn to aluminum.

Tin Situation Still Sad

Look for tin to continue to be scarce through 1947 and part of 1948, though by 1949 production will have caught up with demand. The present price of 70c may change upward, no higher than 75c however, with the market gradually softening by late 1947 as supplies improve and substitutes are more efficient and accepted.

Silver Will Be Cheaper

Prices have already declined somewhat from the top 90c per oz. price, and further drops may be expected because 1946 advances were political rather than economic and politics never wins eventually. Note, too, how Handy & Harman answered the high silver price with effective brazing alloys containing less silver.

In the Plastics Field

In choosing a plastic, gentlemen, the right plastic for the right purpose comes first, of course, but if there is a chance for reshuffling the cards a bit, consider where the best supplies are. Among the nitrocellulose plastics supply equals demand. It is another story in molding phenolics, which are meager in stocks because of the recent coal strike and low phenol output. It will be another story a half year or more hence for output now exceeds 1945, and 1947 output will be double 1945's. You can count on plenty of polystyrenes a few months hence as production early this year will be four times the 1945 output; ten times, by late 1947. Alas, the vinyls! Especially the elastomers! Supply is sufficient for only one-third your demands. The chief bottleneck is the general shortage of plasticizers.

Cheaper Oxygen

You who use oxygen and potential users such as pig iron and steel manufacturers who might well use it in place of air to speed up and cheapen your process—be of good cheer, for cheaper oxygen is just around the corner. War time methods were developed for much cheaper separation of oxygen from the air. There will be simple oxygen plants which you can install at your own works. You will be making your own 0 at 2 to 4c per 100 cu. ft. against 30 to 40c today for what you buy.

AN EDITORIAL.

Shall We Shed a Tear For the Bright New Year?

"Where will we be a year from now?" is the question that's got us down—the worry that wrinkles our widening brow and deepens our darkening frown.

Where will we be on materials—still scrambling for iron and steel? Still staring at shipping dates six months hence, instead of at metal that's real? Still fighting with mills for delivery of sheets and billets and bars, of castings and forgings and 10-gage wire, as far out of reach as the stars?

And what will we pay for the stuff we buy to shape into finished goods? With copper at 20-plus cents per lb.—how *can* we get out of the woods? How *can* we produce at a decent price our autos and washing machines, if steel "modernizes" its schedules again and zinc goes way up in the 'teens?

If Lewis decides that his downtrodden mice away from their mines must stay, will there be any legal or other device that'll guarantee coal in May? Will we listen to Reuther and Murray again and find at the turn of the year that all of our profits when laid end-to-end would just buy each owner a beer?

How we'd love to advise you it's all a dream—a nightmare that soon will be gone. But alas! and alack! things are just what they seem, and they'll not pass away with the dawn! For according to every prediction now, if costs don't go up through the sky destroying all profits you needed, why then—The Recession will moisten your eye!

The Recession? Oh yes, that's The Other Thing that's coming to lay you low—the sad coup de grace that will leave its sting as "over the hill" you go. With everyone working and prices high, and orders a year behind, we're sure to go crashing (don't ask me why—I've not an economist's mind!).

Well, maybe there is just a spark of hope that's springing within my breast, as I think of the thousands of men I know who can't let a pencil rest—who'll boost their production and lower costs with technical ways and means: materials; methods; closer control; bigger and better machines.

Capital, labor and politics can certainly ruin next year; we might save a lot by putting to work the brains of the engineer. So here is our kernel of counsel—the meat of this over-long verse: Things ought to be better next year than now, for how could they ever be worse!

FRED P. PETERS

EDITORIAL COMMENT

Are Engineers "Labor" or "Management"?

The professional and economic status of the rank and file engineer is at a critical juncture, which is right now in the process of being resolved. In the past, no one, including the engineer himself, has taken an active, concentrated and unified interest in the material reward for engineering services and in the position of the engineer in our social structure. This indifference is rapidly vanishing, because of the growing "professional" awareness in the younger engineers and the influence of the Wagner Act which extends collective bargaining rights to engineers.

For a long time engineers were an integral part of management. But as industrial organizations expanded, the average working engineers became separated from central management. This breach between management and the rank and file engineer naturally widened as engineering departments became more highly integrated. Although non-supervisory engineers are still frequently classed with management, in reality their position has approached that of the non-technical white collar worker.

Management neglectfully failed to protect and maintain a comparatively high professional and economic level for engineers. At the same time, engineers failed also to take steps to foster and build up their own professional and economic status. The engineering societies upon which they automatically depended to do this job have turned out to be constitutionally inadequate for that purpose, at least so far as the young engineer is concerned.

The most recent factor to influence the evolution of the engineer's status has been the rise of labor unions. By the unions' aggressive tactics, labor's wages have rapidly increased so that now they closely approach, and in many cases exceed, those of the rank and file technical man. Thus, these two —labor and the engineer—economically, at least, are coming to have the same problems. If this trend should continue, the engineer will be increasingly tempted to switch his traditional, but waning, allegiance from management to labor.

There are thus three courses open to engineers as a group. The one course is to organize a national engineering organization which will serve the professional and economic needs of the engineer and definitely establish engineering as a profession. A second course is to modify and expand the functions of the existing engineering organizations to definitely and actively assume the responsibility for the engineer's economic and professional status.

Right now various technical societies, including the Founder Societies, the Engineers' Joint Council, and a number of smaller local groups, are considering these two methods (or various ramifications) of attacking this organizational problem. There is still wide divergence of opinion, and the hope for immediate unified action along either one of these lines does not seem to be very bright.

The other course remaining is to follow the pattern set by labor—that is, unionize with labor and resort to collective bargaining. Should strong, unified action fail to be taken on one of the other two courses, this third method of dealing with the economic status of the engineers is almost certain to follow.

The actions now and in the near future will determine which of the three courses it shall be. —H. R. C.

Winsor New Publishing Director

Effective January 1, William P. (Bill) Winsor became Publishing Director of MATERIALS & METHODS. Through this move, Mr. Winsor has now assumed complete responsibility and control over all operational activities of this publication. Mr. Winsor, who is also a vice president and director of Reinhold Publishing Corp., publishers of MATERIALS & METHODS, formerly served as associate publishing director. This move was made to permit Mr. P. H. Hubbard, formerly publishing director, to devote full time to his executive duties as president of Reinhold Publishing Corp.

Mr. Winsor has been with Reinhold since 1927—a few years after he finished his formal education at M.I.T.—when he went into the Cleveland territory as district manager for all Reinhold Publications. When *Metals and Alloys* (the forerunner of MATERIALS & METHODS) was established in July, 1929, he acted as its representative. Since that time Mr. Winsor rose steadily in the Reinhold organization, first as advertising manager, *Metals and Alloys* (1931), business manager, *Metals and Alloys* (1937), Reinhold vice president (1943), associate publishing director *Metals and Alloys* (1945), member of the board of directors of Reinhold (1946), and now publishing director of MATERIALS & METHODS.

Through his many years of service in the field of metalworking and fabricating, Mr. Winsor has built up a wide acquaintanceship among companies and individuals connected with engineering materials and their processing.

The editorial staff of MATERIALS & METHODS as well as all his Reinhold associates wish for Mr. Winsor unlimited success in his new responsibility.

MATERIALS & METHODS

JANUARY 1947

• Annual Review of Engineering Materials and Processing Methods

In this issue as with those of January for each of the past several years we present a review of those developments of interest which took place or came into prominence during the last year.

The present review differs radically from those which we have published in the past, in that it contains two basic types of review articles.

The Feature Articles:

In the first half of the feature section will be found seven feature-length articles giving complete details of new developments in the following fields: ferrous metals; nonferrous metals; nonmetallic materials; machining; heat treating; welding, joining and cutting; and, finishing. Many of these articles present the first published details of brand new engineering materials and processing methods.

The MATERIALS & METHODS Manual

Starting on page 87 is MATERIALS & METHODS Manual No. 22 which this month is devoted to a general review of the engineering materials and methods for processing them. This review which represents the efforts of the entire staff of MATERIALS & METHODS will later be available in reprint form for those who may desire additional copies.

• Two New Departments

With this first issue of 1947 we introduce two new departments to which the editors would like to call the readers' attention. On page 8 will be found "The Materials Outlook," a department devoted to interpretation of economic trends in engineering materials. "Outlook" is designed to help engineers plan ahead by pointing out—among other things—likely conditions in prices, delivery and availability of materials. See also "The Last Word" on page 244.

• MATERIALS & METHODS Achievement Award

On the following page will be found details concerning the 1947 MATERIALS & METHODS Achievement Award Competition. Favorable comment following the presentation of awards for the 1946 competition indicates considerable interest in this new effort publicly to acknowledge the intelligent application of engineering materials. Again an exceptionally competent panel of judges has been selected to appraise the entries. The editors urge you to get your own entry in soon.

FIRST CALL FOR ENTRIES

1947 MATERIALS &

Last year MATERIALS & METHODS presented for the first time its annual Achievement Award, established to honor those doing outstanding current work in the development, application and processing of engineering materials. The names of the 1946 winners and descriptions of their achievements were given in our November issue, starting on page 1153.

The basic purpose of these awards is to foster and encourage skillful and enlightened application of engineering materials and processing methods in the solution of widespread industrial production problems. This aim is met (1) by specifying a timely "theme" or problem for each annual award; (2) by conferring the awards for work being done currently or very recently completed, rather than for "time-honored" achievements; and (3) by conducting the

THE 1947 AWARDS

Because the outstanding problem facing the product-manufacturing industries at this time is increasing the production and lowering the cost of their products in the face of several factors pushing in the other direction, the 1947 Awards are to be made specifically

For the most significant use of modern engineering materials and processing methods to increase production and reduce the cost of products now being manufactured.

This is one of the chief ends of sound materials-and-process engineering in any year, but in 1947 it takes on special significance. Every alert manufacturer and engineer in the country has had to plan or re-plan his product and its production from this point of view, and should submit his best production-raising and cost-lowering innovations for Award consideration.

• • •

AWARD CLASSIFICATIONS

This year Awards will be conferred in the following classifications:

(1) ONE GRAND AWARD

(2) THREE SPECIAL AWARDS

a. For achievement in SELECTING AND APPLYING MATERIALS so as to increase production and lower costs of products now being manufactured.

b. For achievement in DEVELOPING NEW ENGINEERING MATERIALS which result in higher production and lower cost of manufactured goods.

c. For achievement in DEVELOPING OR APPLYING PROCESSES OR PROCESSING EQUIPMENT that increase production and lower the cost of manufactured products.

(3) HONORABLE MENTIONS IN ALL CLASSIFICATIONS

The Grand Award winner may or may not be one of the winners of the Special Awards according to the wishes of the Judges.

METHODS ACHIEVEMENT AWARD

competition primarily among men professionally working in our field, (i.e. *users* of materials and processes) although manufacturers of materials and equipment serving the field are also eligible for certain awards.

The competition is concluded in midsummer (entries must be in by June 30th); the entries are judged by an independent Committee of Award consisting of seven nationally prominent engineers and production executives, the editors and publishers of this magazine having no influence whatever on the voting. Entries or nominations are made by the candidates themselves, or their friends, rather than by us or our Judges.

The winners will be announced in the October 1947 issue of MATERIALS & METHODS.

THE JUDGES

The Committee of Award for 1947—the seven men who will appraise your entries and select the winners—are all distinguished manufacturing, design or research executives who have been specially selected for their intimate knowledge of production and cost problems as influenced by the materials and processes used. They are:

RALPH M. HEINTZ — Vice President, Jack & Heintz Precision Industries, Inc., Cleveland
NORMAN L. MOCHEL—Manager, Metallurgical Engineering, Westinghouse Electric Corp., Philadelphia
LOUIS POLK — President, Sheffield Corp., Dayton, Ohio
A. M. SARGENT — President and General Manager, Pioneer Engineering & Manufacturing Co., Detroit, Mich.
WALTER DORWIN TEAGUE — Industrial designer, New York, N. Y.
SAM TOUR — President, Sam Tour & Co., Inc., leading metallurgical engineering consulting laboratory, New York, N. Y.
J. R. TOWNSEND — Materials Engineer, Bell Telephone Laboratories, Inc., Murray Hill, N. J.

Fred P. Peters, Editor-in-Chief of MATERIALS & METHODS, will serve as non-voting Secretary of the Award Committee.

• • •

ENTRIES, CLOSING DATE, ETC.

This competition is open to any individual, company or department of a company engaged in the development or manufacture of mechanical, electrical or other fabricated products or parts, or of materials and processing equipment for such products—whether or not a subscriber to or advertiser in this magazine.

To enter the competition, each candidate must submit a formal entry to the Award Secretary. Entries should consist of a statement of 500 to 1,000 words giving a factual description of the program, application or development involved, with specific proof of the resulting increased production and/or reduced product cost. Elaborate, ornate or "fancy" presentations are strongly discouraged; the achievements will be judged on the basis of the evidence and facts in the entries without regard to their ornamentation and literary quality.

Entries should be addressed to: **FRED P. PETERS, Secretary, Award Committee**
MATERIALS & METHODS, 330 West 42nd Street, New York 18, N. Y.

The closing date for all entries is June 30, 1947. The winners will be announced in the October 1947 issue of MATERIALS & METHODS. The winners will receive suitable engraved plaques or framed certificates, depending on the Award classification, and these will be presented at a dinner to be held in Chicago during the Metal Show, next October.

All questions should be submitted to the Award Secretary, who will gladly and promptly furnish whatever additional information you may wish.

Foamed cellulose acetate is the core material in this wing structure having Fiberglas-resin surfaces.

Foamed Cellulose Acetate—A New Plastic

by **R. A. HOFFER,** *Technical Service Engineer, Plastics Dept., E. I. du Pont de Nemours & Co.*

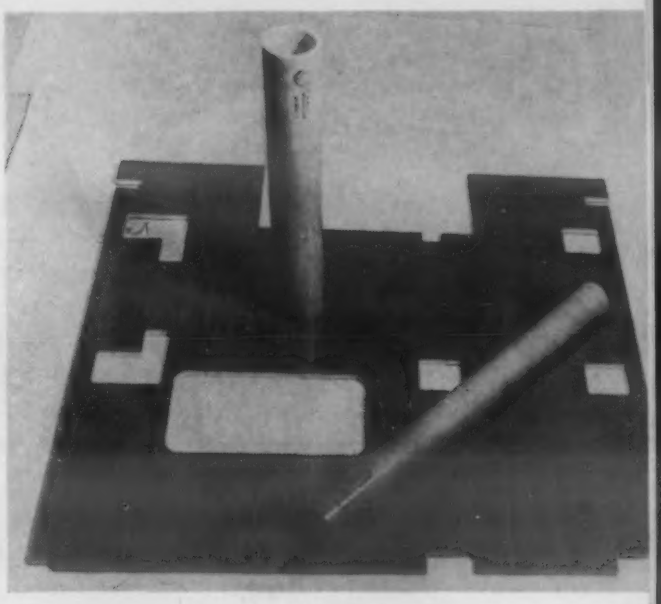
AN OUTSTANDING **1946** DEVELOPMENT IN

NONMETALLIC MATERIALS

RECENT TESTS AT WRIGHT FIELD of a wing structure composed of "Fiberglas"—resin surfaces and a supporting core of foamed cellulose acetate have given additional evidence of the great strength/weight efficiency and the excellent performance made possible by sandwich construction. This unique process of combining high-strength materials for exterior faces with a continuous cellular structure as the core is recognized by aircraft engineers as the logical approach to the problem of reducing the weight of aircraft members without sacrifice of their strength.

Cellular cellulose acetate, or CCA as it is presently designated, is produced by the Plastics Dept. of the du Pont Co. When bonded between two sheets of metal, wood or plastic, this material, which is lighter than cork, contributes remarkable structural strength. The acceptance of the material in the aircraft industry has logically pointed to use in other fields where

Airplane fuselage sections are built-up with foamed cellulose acetate, which serves as a structural core material. (Photo: Courtesy Narmco Inc.)



Here are some of the forms in which this plastic material is used by Narmco Inc.

weight is also a critical factor. Use in tables, bulk heads, ducting, and seat panels for aircraft has led to application in luggage, furniture, boats and even valves for musical instruments.

CCA, cellular cellulose acetate, is a thermoplastic material produced by extrusion. It is cellulose acetate in an unoriented multicellular form. When used as a core material, the function of this product is to increase the rigidity of a sandwich laminate by separating thin faces of high strength and providing continuous support for them. This effect is comparable to that produced by struts in a bridge girder, by which the stiffness of the structure is greatly increased without a corresponding increase in weight. Thus, in a laminate in which CCA is used as a core, a substantial part of the longitudinal compressive strength of the faces may be developed before they can buckle. By the use of this product, structural efficiency and simplicity in design can be achieved, with direct saving in cost as compared to the methods required in making conventional ribbed or otherwise reinforced structures. The specific gravity of CCA ranges from 0.072 to 0.12, depending upon the composition and porosity. An example of its strength/weight efficiency is demonstrated by the following comparison of a composite panel with a plate of steel.

The composite panel, about 1.08 in. thick, was made up of a core of CCA and two faces, each 0.030 in. thick, of "Fiberglas" impregnated with a heat-setting resin. The steel plate, 0.245 in. thick, had the same flexural rigidity (EI) as that of the panel (237,000 psi.), but weighed 7.63 times as much as the panel. When the two were set up as simple beams and loaded in the center, the steel plate carried 655 lb. before taking on a permanent set, while the composite panel carried 698 lb.

The physical properties of CCA compare favorably with those of other core materials. The values in-

crease with the density as shown in the accompanying table of properties. Tests have indicated that the mechanical properties are only slightly different at temperatures as low as −60 to −70 F. The high shear strength of this material and the continuity of its supporting surfaces are outstanding advantages of CCA over cores which are gridded and which thus give only discontinuous support to the face materials.

CCA is produced in four controlled densities, 4 to 5, 5 to 6, 6 to 7, and 7 to 8 lb. per cu. ft. Each density is held within plus or minus ½ lb. per cu. ft. A comparison of the weight of this material with other common materials used in panel construction demonstrates the lightness of the product.

Material	*Density (lb. per cu. ft.)*
aluminum	169.1
white ash	39.8
balsa	7.5 to 12.5
basswood	24.9
beech	40.9
birch	34.5
CCA	4.5 to 7.5
cork	12.9
elm	34.6
magnesium	108.2
poplar	20.7
stainless steel	486.7

CCA is lighter than balsa, and less than one-third as heavy as poplar, which is commonly used as a core material in wood fabrication. A $^{3}/_{4}$-in. panel having $^{1}/_{16}$-in. birch-plywood faces with a poplar core would weigh 1.43 lb. per sq. ft., while a similar panel having CCA (4 to 5 lb. density) as the core would weigh only 0.57 lb. per sq. ft., or less than half as much. It is this very great reduction in weight plus the structural benefits which can be expected from the use of CCA that has led to its adoption in many and varied uses.

The extrusion of CCA is achieved by special equipment. At the present time the dimensions of the extruded strips are restricted to the following by the capacity of the extrusion unit: ½ by 8, ⅝ by 6, ⅞ by 4½, and 1 by 4 in. A new unit which will be placed in operation about the middle of 1947 is expected to produce a strip up to 15 in. wide, with controlled thicknesses from ½ to 1½ in. Special cross-sections such as T's or L's can be extruded from suitable dies.

The extruded strip is prepared for use by shaping and cutting on common woodworking equipment, *i.e.,* sanders, routers, planers, and saws. Strips in thicknesses to 0.100 in. have been cut from thicker strips with bandsaw equipment.

The gluing and compositing of CCA are accomplished with various resin adhesives of the phenol-, melamine-, resorcinol-, and urea-formaldehyde types. Solvents which attack the cellulose acetate and tend to break down the cell structure must be avoided in choosing an adhesive. When water is used to prepare the adhesive for use, a thick dope is preferred to a thin solution, in order to prevent excessive penetration of the surface cells. For this reason, film-type adhesives are recommended.

As in the design of any other laminate, the two faces should be of the same material of the same thickness in order to prevent setting up of unbalanced stresses in service.

Property*	CH-145	CH-167	Test Method
MECHANICAL			
Tensile Strength:			
77 F, psi.	95	175	(1)
170 F, psi.	95	125	(1)
Compressive Strength:			
ultimate, psi.	75	125	ASTM D695-42T
2% deformation, psi.	70	100	ASTM D695-42T
modulus, psi.	3,500	5,500	compression data
Shear Strength:			
in tension, psi.	100	140	(2)
in compression, psi.	85	125	(3)
impact strength, Izod unnotched ft.-lb.	0.08	0.08	(4)
THERMAL			
Coefficient of Linear Expansion, per deg. F	2.5×10^{-5}	2.5×10^{-5}	(5)
Thermal Conductivity BTU/ft.²/hr./deg. F/in.	0.3	0.31	Cenco-Fitch apparatus
MISCELLANEOUS			
Density, lb./cu. ft.	4.5	6.5	ASTM D71-27
Moisture-Absorption			
50% RH, lb./cu. ft.	0.15	0.15	(6)
100% RH, lb./cu. ft.	0.6	1.05	(7)
Water-Absorption, lb./cu. ft.	5.5	4.5	ASTM D570-42
Expansion by Moisture	3×10^{-3}	3×10^{-3}	direct measurement at equilibrium
Burning Rate, in. per min.	1.9	1.4	ASTM D635-42T

* *The data and opinions herein are the result of painstaking laboratory work. However, differences in technique or in operating conditions from one shop to another, and variations which can normally be expected in such a core material, may cause deviations from the figures given. Data reported represent measurements made on early production runs and are subject to modification as larger quantities of these materials are produced and as more experience with their properties is obtained.*

(1) Samples ¾ by 1 by ½ in. glued to maple blocks. Tested at 0.2 in. per min. loading speed. Load applied parallel to direction of thickness.

(2) Piece 1 by 1 by ⅛ in. glued to ⅛-in. birch plywood. Load in tension applied perpendicular to ⅛-in. dimension at a rate of 0.2 in. per min.

(3) Two specimens ½ by 1 by 1 in. glued to three maple blocks. Tested with Johnson jig.

(4) Unnotched specimens ½ by ½ by 2½ in. Izod impact.

(5) Direct measurement within the range of 77 F to 170 F.

(6) Gain in weight from 0% RH to 50% RH.

(7) Gain in weight from 0% RH to 100% RH.

In bonding the laminate, temperature and pressure should be uniform over the entire area, to prevent warpage. It is generally advisable to band the edges of the panel in order to confine the core during lamination. Only light bonding pressures should be used, to prevent strains being built up in the core material. Temperatures up to 300 F can be used to set up the adhesives. If high-frequency heating is applied to composite the CCA laminate, the curing time can be reduced to 15 sec. or less.

Shaped While at Softening Point

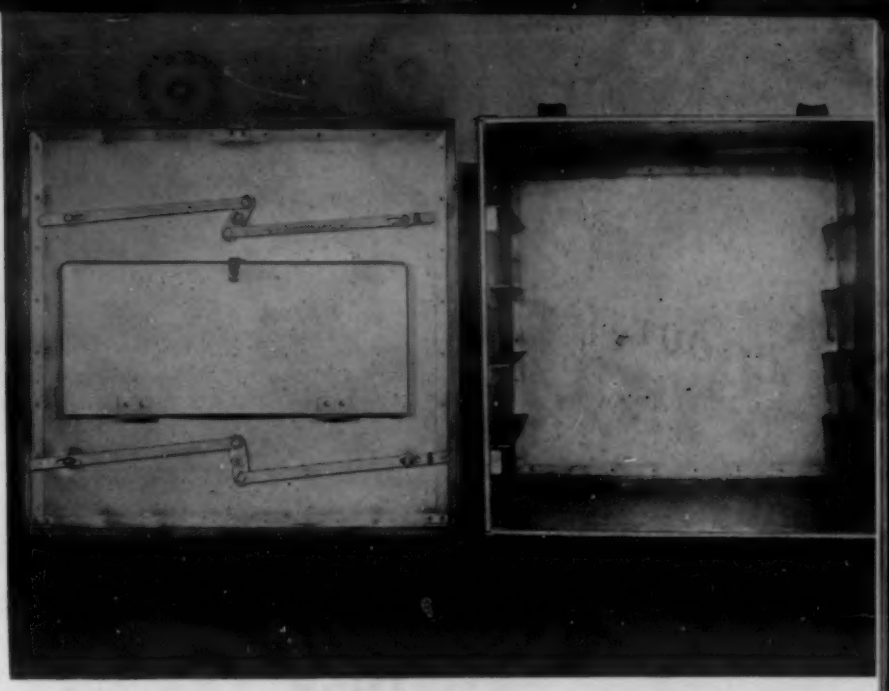
Du Pont CCA has a relatively sharp softening point within the range of 390 to 400 F (199 to 204 C). Shaping can be done within this temperature range. In shaping, it is generally advisable to use hot dies, since the surface cells become brittle quickly as they cool. Prolonged heating at the shaping temperature will partially decompose the cellulose acetate, and heating to a higher temperature than 400 F will melt the material.

If a series of parallel cuts or kerfs is made in a panel of CCA by running it under a horizontal gang router, the section can be bent into a curve at room temperature. Any reasonable radius of curvature can be achieved by this method through suitable variation in the spacing of the cuts. In a panel of thickness 0.50 in., the kerfs should be cut to a depth of 0.40 to 0.44 in. The deeper cuts are necessary for materials of the higher densities. The same proportionate depth should be maintained in all thicknesses. It is generally advisable to use wedge-shaped kerfs (10 deg.) if possible, in order to ensure closing of the cuts when the panel is shaped. If glue is applied to the wedge-shaped kerfs prior to closing, the shaped core will be of multiple sandwich-type section and be considerably stronger than the initial core.

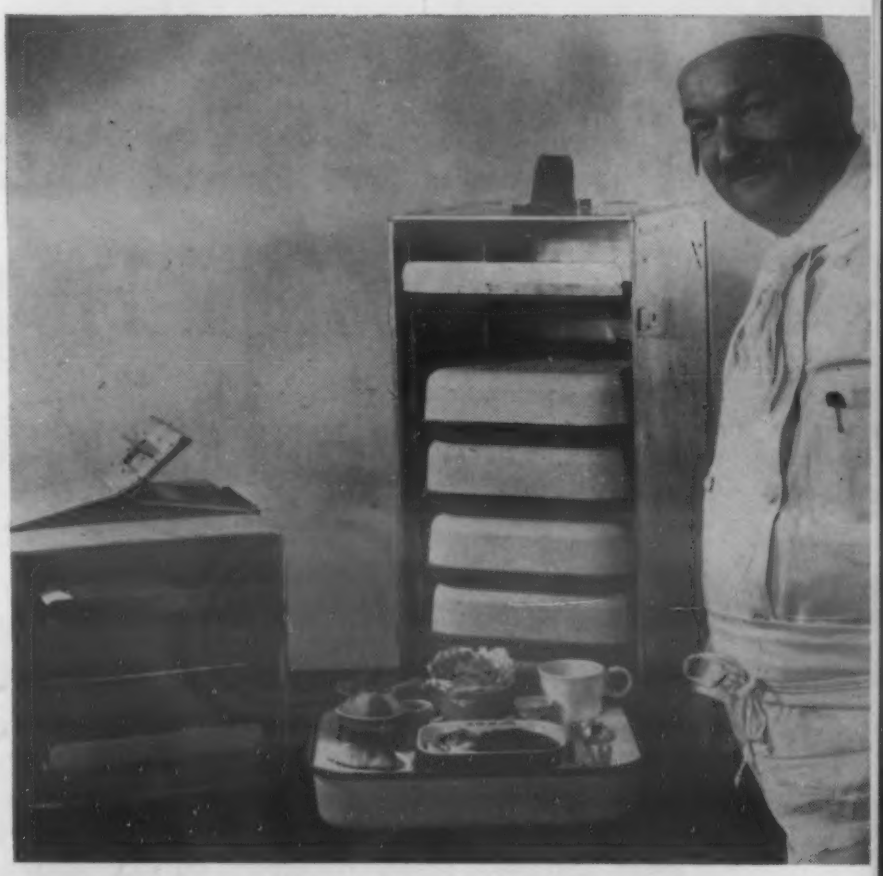
Another method of obtaining great strength is to laminate one skin to the CCA panel, kerf the half laminate with wedge-shaped cuts all the way through the core, and then apply a resin adhesive to the seams and shape the corner. The shaped core will have ribs of adhesive running through the entire thickness of the core, bonding directly to the face material.

Shaping of CCA panels can be accomplished also by first bonding one skin to the panel, or suitably wedging the CCA panel against the skin so that it is completely supported by that skin, and then bending the combination to the desired shape while keeping the thin skin surface on the outside of the bend. Shaping can be done at room temperatures by this method.

The following uses are being developed for CCA:



The insulating qualities of foamed cellulose acetate make it suitable for such applications as this box for transporting frozen cooked meals.



Meals to be served aloft are kept crisp and attractive in these storage boxes produced by Skydyne, Inc. The boxes are aluminum with CCA cores. (Photo: Courtesy United Air Lines.)

Aircraft

fuselage sections
wings
aileron tabs
doors
empennage assemblies
tail boom assemblies
antenna housings
flooring
pontoons
tables
bulkhead panels
cabinets
collapsible tables
food boxes
transit boxes
refrigerator units

Domestic

furniture
movable partitions
decorative panels
portable refrigeration units
sectioned cabinets
doors
luggage
fishing-tackle boxes

Transportation

truck panels
boats
railroad-car panels

Miscellaneous

musical instruments
insulation plugs
life belts
surfboards

AN OUTSTANDING
1946
DEVELOPMENT IN

FERROUS METALS

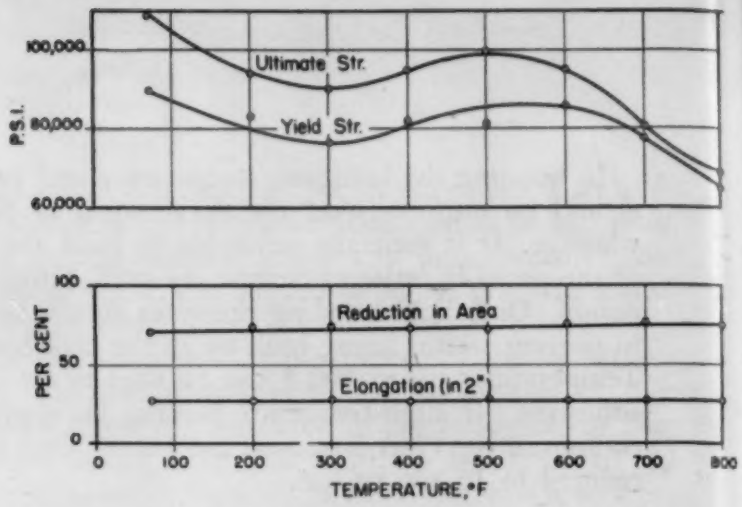


Fig. 1—Effect of temperature on the physical properties of 9% nickel steel.

New 9% Nickel Steel Tubing— Properties and Processing

by H. D. NEWELL, J. A. MANFRE & M. A. CORDOVI, *Babcock & Wilcox Tube Co.*

LOW CARBON 9% NICKEL STEEL was heretofore mainly a metallurgical curiosity and unavailable to industry in the form of seamless tubing. This material is especially advantageous for use as tubing in view of its greater resistance than ordinary carbon or low alloy steels to corroding influences from alkaline media, such as sodium hydroxide solutions and paper mill black liquors, to certain oil well fluids containing chloride salts and hydrogen sulfide in the oil-water liquids, and to corrosion by certain organic acids and carbonic acid as occurs in so-called gas distillate wells. It has useful properties also as a carburizing steel in certain of its modifications, and it provides good toughness or resistance to impact thereby lending itself to applications at sub-atmospheric temperatures.

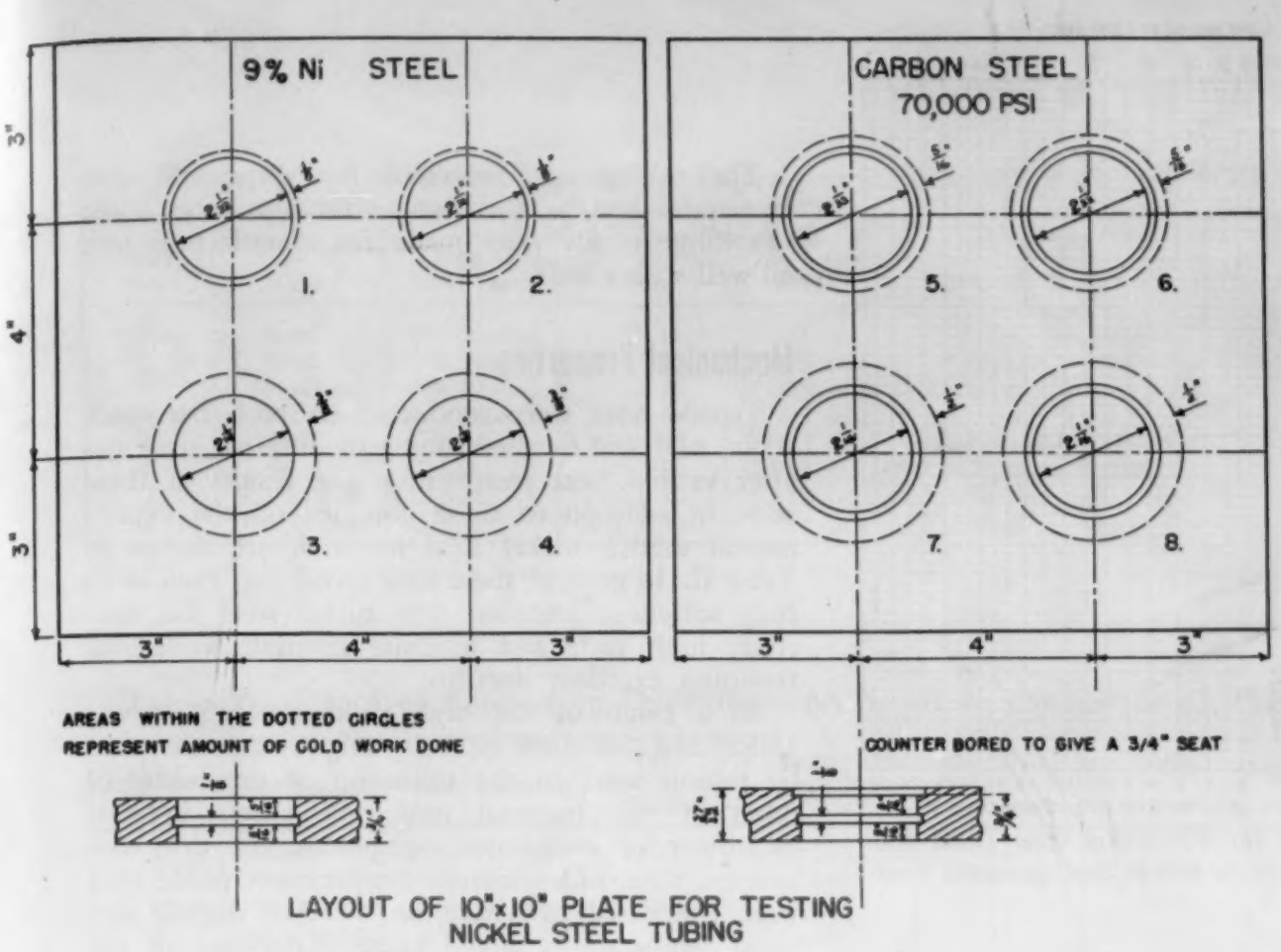
In such services, 9% nickel steel becomes useful to the oil and chemical industry and to other industries when used in the form of tubing, pipe, casing or other containers; also as castings, valves, fittings and as sucker rods and other appurtenances for producing and refining oil or hydrocarbon fluids. It is particularly useful as heat exchanger, condenser or evaporator tubing, and as pipe for conveying liquids including liquefied gases at low temperatures. Furthermore, this low carbon alloy steel combines high physical strength with excellent ductility.

This article describes the mechanical and working characteristics, the heat treating behavior and the weldability of this newly developed product and suggests fields of application.

Prior to the manufacture of commercial quantities of 9% nickel steel tubing, preliminary development work was undertaken to determine the mechanical and fabricating characteristics of a special 8.50%

Table I—Chemical Composition of Commercial Heats

Heat No.	COMPOSITION, Per Cent						
	C	Mn	Si	Cr	Ni	Cu	Mo
14321	0.06	0.47	0.18	0.11	8.96	0.35	0.05
14322	0.09	0.41	0.20	0.04	9.12	0.23	0.04
14323	0.07	0.46	0.24	0.03	8.94	0.36	0.04
14324	0.07	0.44	0.18	0.09	9.04	0.39	0.04
14325	0.06	0.47	0.22	0.10	8.90	0.30	0.07
14326	0.07	0.47	0.17	0.03	8.80	0.37	0.06



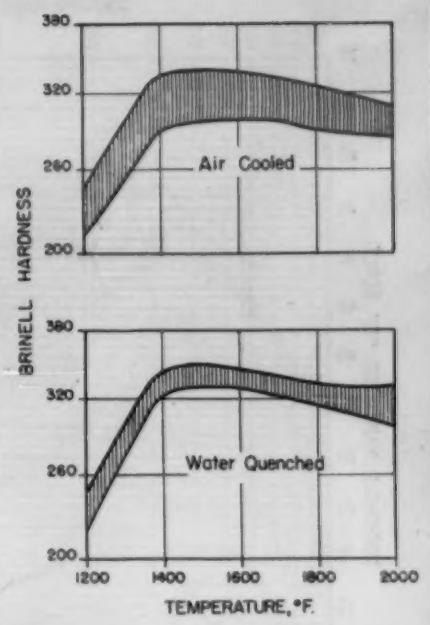


Fig. 3—Hardening range of 9% nickel steel for both air cooling and water quenching.

nickel alloy steel which was under investigation for low temperature application in pressure vessels.

This steel showed such satisfactory fabricating properties and mechanical characteristics at 70 F and –320 F that several 15-ton basic electric furnace heats of 9% nickel steel (B&W Nicloy 9*) were made at our steel plant to fill commercial tube orders for the material. All heats were fine grained (6-7 (5)) as determined by the standard McQuaid-Ehn carburizing test, and their composition is given in Table I.

** This steel has been given the trade name B&W Nicloy 9, the trademark "Nicloy" being registered in the United States Patent Office.*

Table II—Physical Properties of 9% Nickel Steel

Size	Condition	Ultimate psi.	Yield psi.	Elong. % 2 in.	Red. Area	BHN
BAR STOCK						
3 in. rd.*	As rolled	98,000	74,650	27.0	61.2	260
3 in. rd.*	As rolled, tempered 1125 F	97,000	70,650	26.0	61.2	210
3 in. rd.	Nor. 1575 F, tempered 1050 F	108,250	89,750	27.5	70.4	231
TUBING						R_b
3¼ in. x ¼ in.*	As rolled	116,200	91,500	24.0		103
3¼ in. x ¼ in.*	As rolled, tempered 1125 F	119,000	94,000	27.0		95
2 in. x 0.120 in.*	Nor. 1625 F	103,200	76,200	45.0		92
1¼ in. x 0.049 in*	Nor. 1625 F	102,700	73,200	35.0		94
¾ in. x 0.049 in.*	Nor. 1625 F	103,700	75,400	31.0		94
1.90 in. x 0.145 in.	Nor. 1575 F	131,800	95,200	28.0)		
1.90 in. x 0.145 in.	Nor. 1575 F	134,000	92,550	29.0)		
2.031 in. x 0.134 in.	Nor. 1575, tempered 1075 F	108,200	84,200	37.0)		
2.031 in. x 0.134 in.	Nor. 1575, tempered 1075 F	115,600	89,800	33.0)		
2.031 in. x 0.134 in.	Nor. 1575, tempered 1075 F	114,100	95,600	34.0)		
2.031 in. x 0.134 in.	Nor. 1575, tempered 1075 F	110,500	90,800	34.0)		95-98
2.031 in. x 0.134 in.	Nor. 1575, tempered 1075 F	114,000	97,800	37.0)		
2.031 in. x 0.134 in.	Nor. 1575, tempered 1075 F	122,200	89,900	35.0)		
2.031 in. x 0.134 in.	Nor. 1575, tempered 1075 F	110,850	94,850	36.0)		
2.031 in. x 0.134 in.	Nor. 1575, tempered 1075 F	110,500	94,000	34.0		
2.031 in. x 0.134 in.	Nor. 1575, tempered 1075 F	111,500	88,900	35.0		

** Experimental 8.50% nickel steel.*

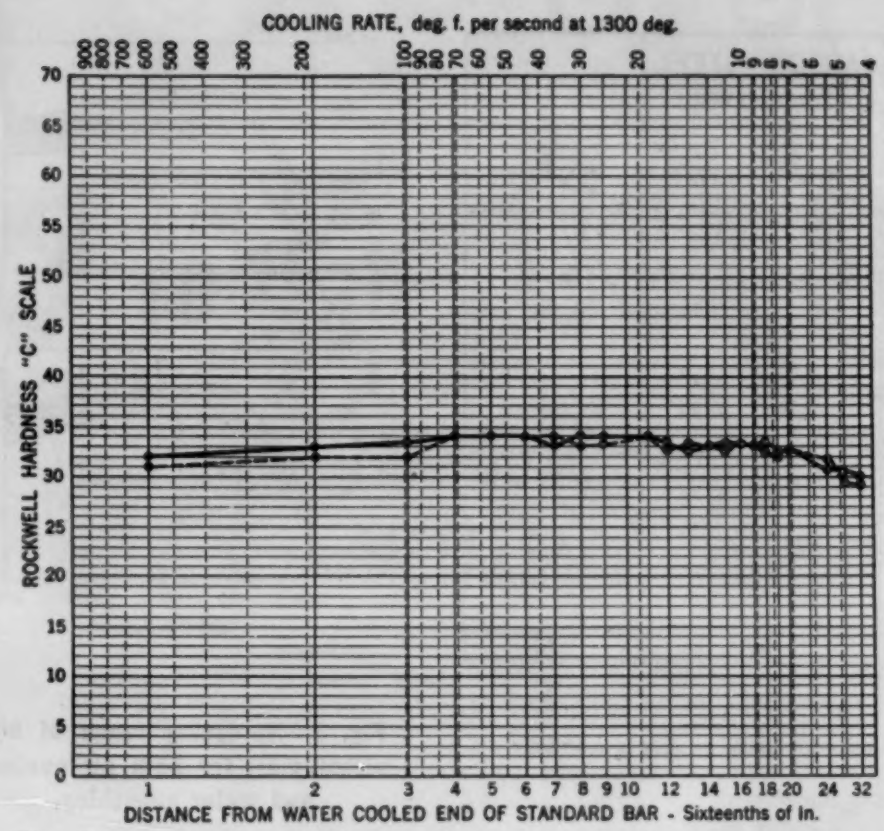
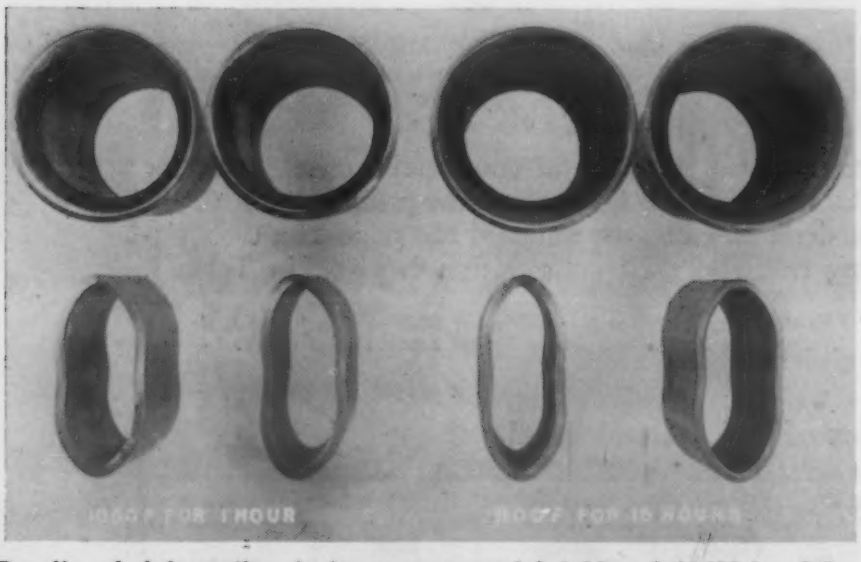

COOLING RATE, deg. f. per second at 1300 deg.
ROCKWELL HARDNESS "C" SCALE
DISTANCE FROM WATER COOLED END OF STANDARD BAR - Sixteenths of in.

Fig. 4—Results of end-quench test for 9% nickel steel (Heat No. 14324). Full line, quenched from 1400 F; broken line, quenched from 1600 F.



Results of deformation tests on commercial tubing 2-11/32-in. O.D. and 3/4-in. wall thickness.

Table III—Effect of Time at 1050 F and 1100 F on the Yield Strength of 9% Nickel Steel Tubes

Temperature F	Time	Yield* psi.	Ultimate psi.
1050	5 hr.	97,200	—
1050	8 hr.	92,200	—
1050	15 hr.	85,600	—
1100	1 hr.	93,400	109,500
1100	15 hr.	73,500	113,700
1100	20 hr.	73,000	113,200

* *Yield strength obtained by dividers. Size of specimens 2.031 in. O.D. by 0.134 in. wall. All specimens were normalized at 1575 F prior to heating at designated temperature.*

The tubing was processed into pipe and into evaporator and heat exchanger tubing. Later, some re-rolling rounds were made for manufacture into oil-well sucker rods.

Mechanical Properties

Tensile tests were conducted on both bar stock (3-in. rd.) and finished tubing of different sizes and after various heat treatments. The results of these tests, in addition to those obtained on the experimental 8.50% nickel steel material, are shown in Table II. In general, these data reveal that even in its fully softened condition, 9% nickel steel has relatively high yield and ultimate strength while still retaining excellent ductility.

As a result of the high yield strength, it was anticipated that some difficulty might be encountered by tubing users in the rolling-in or expanding of tubes of this material into tube sheets in heat exchanger or evaporator equipment. In this connection, short-time elevated temperature tensile tests were conducted to determine whether slightly elevated temperatures would cause a decrease of the yield strength of sufficient magnitude to facilitate rolling-in of tubes of 9% nickel steel into tube sheets. These tests were also intended to establish whether this material has a blue brittle heat range.

The results of these tests, which were conducted on standard 0.505-in. dia. specimens machined from 3-in. rounds, are depicted graphically in Fig. 1. They show that the yield and ultimate strength values are slightly decreased upon heating at 200 F and 300 F, indicating that some advantage may be gained by preheating the ends of 9% nickel tubes for rolling them into tube sheets. These test results show also that there is a slight stiffening effect on this material between 400 F and 600 F, as is indicated by the minor increases of yield and ultimate strengths. However, this range should not be considered as a blue brittle range such as occurs in carbon steels, since it has no detrimental influence on the elongation and reduction in area of this fully deoxidized nickel steel.

Table III shows the effect of time on the yield strength at temperatures of 1050 F and 1100 F. The experimental results reveal that the yield strength can be effectively reduced from approximately 100,000 psi. to 73,500 psi. by heating at 1100 F for 15 hr. where maximum softness is required.

Tube Expanding

For comparison purposes, the tests described herein were run on duplicate samples of nickel steel and plain carbon steel tubing measuring 2-in. O.D. by 10 B.W.G. Two samples of each type were rolled into 9% nickel steel plate and the other two into carbon steel plate. A tube seat ¾-in. wide with a single groove was used. The plates were laid out as illustrated in Fig. 2. All the tubes were rolled-in in the same manner following standard field practice. After rolling, the tube ends were not belled and the tubes were tested for joint strength by pushing them out of the seats under a hydraulic press.

Table IV—Results of Expanding Experiments Conducted on 9% Nickel Steel Tubes

Tube No.	Type of Tube	Type of Steel Plate	Seat Diameter		Tube Diameter		Amount Scale Chipping	Pushout Values in lb.
			Before	After	Before	After		
1	C Steel	9% Nickel	2.037 in.	2.041 in.	1.993 in.	2.075 in.	⅛ in.	49,600
2	C Steel	9% Nickel	2.037 in.	2.039 in.	1.993 in.	2.075 in.	⅛ in.	50,500
3	9% Nickel	9% Nickel	2.072 in.	2.085 in.	2.023 in.	2.102 in.	⅜ in.	30,500
4	9% Nickel	9% Nickel	2.073 in.	2.091 in.	2.023 in.	2.121 in.	⅜ in.	52,500
5	C Steel	C Steel	2.037 in.	2.045 in.	1.992 in.	2.097 in.	5/16 in.	46,000
6	C Steel	C Steel	2.037 in.	2.053 in.	1.992 in.	2.104 in.	5/16 in.	44,000
7	9% Nickel	C Steel	2.071 in.	2.113 in.	2.028 in.	2.154 in.	½ in.	39,800
8	9% Nickel	C Steel	2.071 in.	2.113 in.	2.028 in.	2.154 in.	½ in.	39,000

Note: The carbon steel plate used had a minimum tensile strength of 70,000 psi. and the nickel tubes had a yield strength on the order of 90,000 to 100,000 psi.

Table V—Effect of Expanding Operations on Hardness Properties of 9% Ni Steel Tubing

Specimen No.	Tube Material	Plate Material	Tube Metal Hardness (BHN)			Plate Metal Hardness (BHN)		
			Before*	After†	Net Increase	Before*	After†	Net Increase
1	C steel	9% Ni steel	140	185	45	195	219	24
2	C steel	9% Ni steel	137	185	48	195	220	25
3	9% Ni steel	9% Ni steel	249	298	49	195	222	27
4	9% Ni steel	9% Ni steel	230	282	52	195	262	67
5	C steel	C steel	131	178	47	132	172	40
6	C steel	C steel	132	181	49	132	179	40
7	9% Ni steel	C steel	229	283	54	132	174	42
8	9% Ni steel	C steel	228	281	53	132	188	56

** Prior to expanding.*
† After expanding.

Table VI—Results of the Charpy Impact Tests at Room Temperature and Minus 320 F (Specimens from 3-in. Rd. Bars)

Heat No.	Longitudinal Specimens Normalized 1575 F			Longitudinal Specimens Normalized 1575 F Reheated 1050 F			Transverse Specimens Normalized 1575 F Reheated 1050 F		
	R.T.	—320 F	BHN	R.T.	—320 F	BHN	R.T.	—320 F	BHN
14321	36	20.5	288-301	56	47.3	231-234	28.0	21.8	231-234
14322	38	20.5	275-281	55	41.5	227-227	30.0	21.0	229-229
14323	40	24.0	255-273	54	37.0	227-227	26.5	16.7	224-229
14324	35	21.0	296-305	—	47.3	238-245	32.5	20.3	236-236
14325	35	20.5	293-305	50	47.8	238-243	32.0	18.8	239-241
14326	35	19.0	332-336	48	47.8	250-255	25.5	17.0	252-255
Average	36.5	20.9		52.6	44.8		29.1	19.3	

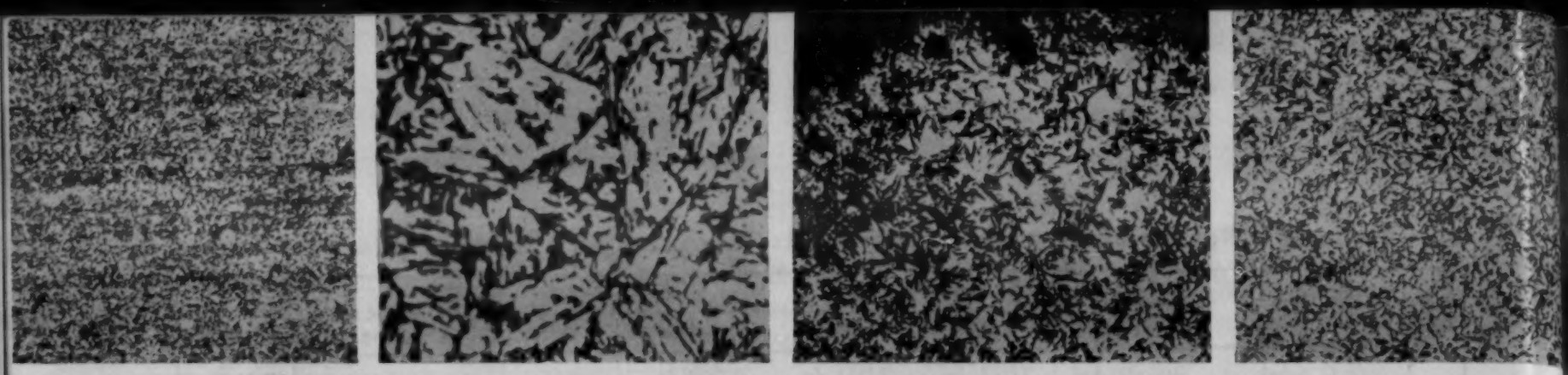
Note: Room temperature impact results are from one test only, while the low temperature results are the average of three tests.

The results of these tests (Table IV), indicate that 9% nickel can be successfully expanded into both 9% nickel steel and carbon steel plate, with the tightest joint resulting where 9% nickel steel plate is also used in conjunction with the 9% nickel steel tubes.

When rolling 9% nickel steel tubes into tube sheets, it is recommended that as close a fit as possible be secured between the tube and the tube seat so as to minimize the amount of cold work on the tube. It is also advisable to use a three-roll expander of the parallel roll type in preference to one containing four or more rolls.

After the expanding experiments were completed, the rolled portion of the tubes and the seats were sectioned and a Rockwell hardness survey was made to determine the extent of hardness induced by cold working. The results, converted to Brinell hardness numbers, are shown in Table V.

These data revealed an increase in hardness of from 49 to 54 BHN of the nickel steel tubes and from 45 to 49 BHN of the carbon steel tubing material. It is apparent from these values that nickel steel tubes are only slightly more subject to work hardening by the expanding process than are the plain carbon steel tubes. A minimum amount of cold work on installation is desirable, of course, to lessen the possibility of stress-cracking (caustic embrittlement) when the material is employed in evaporating solutions which are alkaline in character.



Figs. 6, 7, 8 and 9—Fig. 6 (left) shows typical structure of normalized and drawn tubing with banding still in evidence (X 100). Fig. 7 (left center) is the same as Fig. 6 but at X 100 magnification. Fig. 8 (right center) shows a completely martensitic structure at X 100 after a Nital etch. Fig. 9 (right) shows core structure to be similar to the "as rolled" structure except for the presence of finer carbides (X 100). All samples were Nital etched.

Impact Properties

Notch-impact tests at room temperature and at minus 320 F were conducted to investigate the effect of low temperature on the toughness of 9% nickel steel. The specimens used were of conventional Charpy keyhole type and were cut longitudinally to the direction of rolling from 3-in. billet stock of several commercial heats. The influence of the directional properties in these heats on the impact strength was also studied on Charpy specimens cut transversely to the direction of rolling.

The results of the notch-impact tests are summarized in Table VI and show conclusively that of all the specimens tested, the longitudinal specimens that were normalized and then reheated at 1050 F exhibited the greatest impact strength both at room temperature and at minus 320 F. Notwithstanding the comparatively lower impact values of the normalized and reheated transverse specimens, they still exceed 15 ft.-lb., which is the arbitrary minimum value required at the service temperature specified.

The impact test fractures of the normalized and drawn longitudinal and transverse specimens tested at minus 320 F showed that the longitudinal specimens broke with a tough, ductile, fibrous fracture, whereas the transverse specimens exhibited a more brittle crystalline-type fracture, although it was still of a partially fibrous nature indicating some retention of toughness at −320 F.

It is well known that nickel, when added to ferritic steels, lowers the initial temperature of the beginning of the ductile-brittle structure transition range and also decreases the rate of loss through this range, in addition to increasing the impact strength at room temperature. Accordingly, a steel containing upwards of 9% nickel offers better toughness at lower temperatures than steels containing a lesser amount of this element, especially when service temperatures are below about −240 F.

Table VII—Results of Temper-Embrittlement Susceptibility Tests

Heat Treatment	Charpy Notch-Impact (Keyhole) Values Ft.-Lb.	Susceptibility Ratio
	Room Temperature Tests	
Furnace cooled (10 F/hr.) from 1100 F	50.0; 50.5; 51.5 (average: 50.7)	1.10
Water quenched from 1100 F	55.0; 56.5; 56.5 (average: 56.0)	
	−320 F Temperature Tests	
Furnace cooled (10 F/hr.) from 1100 F	31.5; 25.5; 30.0 (average: 29.0)	1.53
Water quenched from 1100 F	45.0; 47.0; 41.5 (average: 44.5)	

Note: Specimens normalized at 1575 F and reheated at 1100 for 2 hr.

Table VIII—Effect of Tempering Temperature on the Hardness of Heat 14324 in Terms of BHN

Temperature F	Tempering Time		
	15 Min.	1 Hr.	3 Hr.
1000	259	241	234
1050	244	241	231
1100	241	241	232
1125	242	253	259
1150	249	255	275
1175	236	253	269
1200	244	293	290

Note: All specimens were normalized at 1575 F for 15 min. prior to tempering, with a resulting hardness of BHN 290 to 312.

Temper-Embrittlement

In order to secure information relative to the susceptibility of 9% nickel steel to temper-embrittlement, a test devised by Greaves and Jones ("Temper-Brittleness of Steel; Susceptibility to Temper-Brittleness in Relation to Chemical Composition," *Iron & Steel Inst.* (British), Vol. III, No. 1, 1925, p. 231) was made at room temperature and minus 320 F.

Two sets each comprised of six longitudinal Charpy impact specimens were normalized at 1575 F and tempered at 1100 F for 2 hr. One set was cooled rapidly by water quenching from the tempering temperature, whereas the other set was cooled slowly at a rate of 10 F per hr. to 700 F. Three specimens from each set were then tested at room temperature while the remainder of the set was tested at minus 320 F.

The degree of susceptibility to temper-embrittlement is determined by the ratio of impact strength of the rapidly cooled specimens to that of the slowly cooled ones, with unity signifying no susceptibility. The ratios of susceptibility so determined are listed in

Table IX—Static Tensile and Bend Ductility Characteristics of Flash-Butt and Arc Welded 9% Nickel Steel Tubing

Spec. No.	Type of Weld	Condition of OD and ID Flash or Bead	Heat Treatment	Yield Point Psi.	Tensile Strength Psi.	Elongation in 2 in. %	Location of Fracture	Bend Angle Degrees	
								Face	Root
1	Flash	Machined flush	A*	112,200 115,900	122,250 122,300	16.0 19.0	Away from weld Away from weld	180	 180
2	Flash	Left as reinforcing band, 1/64 in. thick on OD	A	111,200 112,800	117,200 119,950	16.0 19.0	Away from weld Away from weld	180	 180
4	Flash	Ground flush	A	119,500 119,700	123,100 120,400	16.0 16.0	Away from weld Away from weld	180	 180
3	Flash	Ground flush	B†	113,600 121,000	116,800 127,250	18.0 18.0	Away from weld Away from weld	180	 180
8	Flash	Left as reinforcement, 1/64 in. thick on OD	B	114,400 124,300	123,500 126,600	16.0 17.0	Away from weld Away from weld	180	 180
9	Flash	Ground flush	B	117,500	125,700	27.0	Away from weld	180	—
5	Arc	Ground flush	A	69,400 88,000	121,400 125,900	5.0 8.0	Weld Away from weld	180	 180
7	Arc	Ground flush	None	105,600 109,950	121,400 124,800	5.0 5.0	Weld Weld	180	 120
10	Arc	As welded	A	64,200 59,800	119,900 117,250	4.0 4.0	Weld Weld	180	 120
6	Arc	Ground flush	A	81,000	119,000	5.0	Weld	—	—

* *A—2 hr. at 1050 F, air cooled.*
† *B—2 hr. at 1050 F, water quenched.*

Table X—Results of Charpy Impact Tests at + 70 F and —320 F on 9% Nickel Steel Tubing

Spec. No.	Test Temp. F	Type of Notch	Location of Notch	Charpy Test Values for ¼ Size Specimens		Estimated Values (Ft.-Lb.) for Standard Size Specimens*	
				Ft.-Lb.	Percent of Value at +70 F		
1	+ 70	Keyhole	Weld	13.5	—	33.7	
1a	—320	Keyhole	Weld	8.0	59.3)	20.0)	
2a	—320	Keyhole	Weld	8.0	59.3) 59.3 Av.	20.0)	20.0 Av.
3a	—320	Keyhole	Weld	8.0	59.3)	20.0)	
2	+ 70	V	Weld	14.0	—	35.0	
2a	—320	V	Weld	11.5	82.1)	28.7)	
2b	—320	V	Weld	11.0	78.5) 79.7 Av.	27.5)	27.9 Av.
2c	—320	V	Weld	11.0	78.5)	27.5)	
3	+ 70	Keyhole	Heat Aff.	13.5	—	33.7	
3a	—320	Keyhole	Zone	12.0	88.8)	30.0)	
3b	—320	Keyhole	Zone	12.0	88.8) 90.1 Av.	30.0)	30.4 Ave.
3c	—320	Keyhole	Zone	12.5	92.6)	31.2)	
4	+ 70	V	Heat Aff.	19.0	—	47.5	
4a	—320	V	Zone	14.0	73.6)	35.0)	
4b	—320	V	Zone	14.0	73.6) 73.6 Av.	35.0)	35.0 Av.
4c	—320	V	Zone	14.0	73.6)	35.0)	

* *Working values were estimated on the assumption that the ¼ size specimens (0.098 in. by 0.394 in.) represented 40% of standard size values at temperature tested.*

Table VII. These results indicate that 9% nickel steel is only slightly sensitive (ratio 1.1) to temper-embrittlement at room temperature. Although the ratio of susceptibility (1.53) was greater at minus 320 F, the average impact strength (29.0 ft.-lb.) of the furnace cooled specimens was still well above the usually prescribed minimum impact strength at minus 320 F.

(Continued on page 159)

The strength and attractiveness of Almag make it ideally suited for such applications as this cast housing.

New Strong Aluminum Casting Alloy

by **HAROLD KNIGHT,** *News Editor,* MATERIALS & METHODS

AN OUTSTANDING **1946** DEVELOPMENT IN

NONFERROUS METALS

ONE OF THE PHYSICAL PROPERTIES limiting the use of sand cast aluminum alloys as materials of construction is their relatively low strength. In addition to a price differential, aluminum castings must overcome a strength handicap in competing with malleable iron, many alloy steels, and some nonferrous metals. A new casting alloy of aluminum, with minimum tensile strength of about 60,000 psi., offers promise of strength really meeting values of malleable iron and some steels, and offering aluminum's weight saving and corrosion resistance as premiums to offset the price differential.

In the search for alloying elements to improve the strength of aluminum, the copper-bearing alloys, produced during the first World War and the years immediately following, were early developments. They still form one of the most important series. Silicon contributed valuable properties in another group. The zinc-bearing alloys, with high strength and age-hardening, have been produced in recent

years in this country after an earlier acceptance in Germany.

It was natural that alloys with the other light structural metal, magnesium, should be investigated, and the alloy designated as 220, containing nominally 10% magnesium, has been a standard composition for a number of years. It is a sand casting alloy, with specific gravity of about 2.56 as compared with the 2.78 to 2.83 of compositions bearing percentages of the heavier metals. Strength properties have been comparable to those of other sand casting alloys of aluminum, but have shown no superiority. A minimum tensile strength of 42,000 psi. would be representative.

The new alloy, produced by Acme Aluminum Alloys, Inc., is based upon magnesium as an alloying element, and uses about 11% of the light metal, placing it in the same general class as the 220 alloy. Addition of fractional percentages of beryllium and boron, and use of special techniques during melting and casting, have accounted for the considerable increase in tensile strength, impact strength, elongation, and high corrosion resistance. It has been designated as Almag 55, the "55" indicating the minimum specified tensile strength. Like the 220 alloy, it is heat treatable, and the values given are those reached in the fully heat treated and aged condition.

Nominal composition for the new alloy is:

Magnesium	11.20%
Boron	0.40%
Beryllium	0.20%
Silicon	0.20% max.
Iron	0.20% max.
Copper	0.20% max.
Other impurities	0.10% max. each
Aluminum	balance

A companion alloy, with lower magnesium content and correspondingly lower strength but greater ease of casting, is listed as Almag 35. A minimum specified tensile strength of 35,000 psi. is indicated. This alloy is produced in two variations, as shown:

For Strength		*For High Finish*	
Magnesium	6.0%	Magnesium	4.0%
Boron	0.4%	Boron	0.4%
Beryllium	0.1%	Beryllium	0.1%
Impurities as above		Impurities as above	

These compositions are not heat treatable.

The new alloy has its antecedents in the aluminum-magnesium compositions developed at the beginning of the century, and popular under the name "magnalium." These contained 3 to 10% magnesium. The types of higher magnesium content were revived during the recent war years, and were used in considerable quantity. These contained 9.5 to 11% magnesium, and were required to possess a minimum tensile strength of 42,000 psi. with a minimum elongation of 12%, according to applicable Army-Navy specifications.

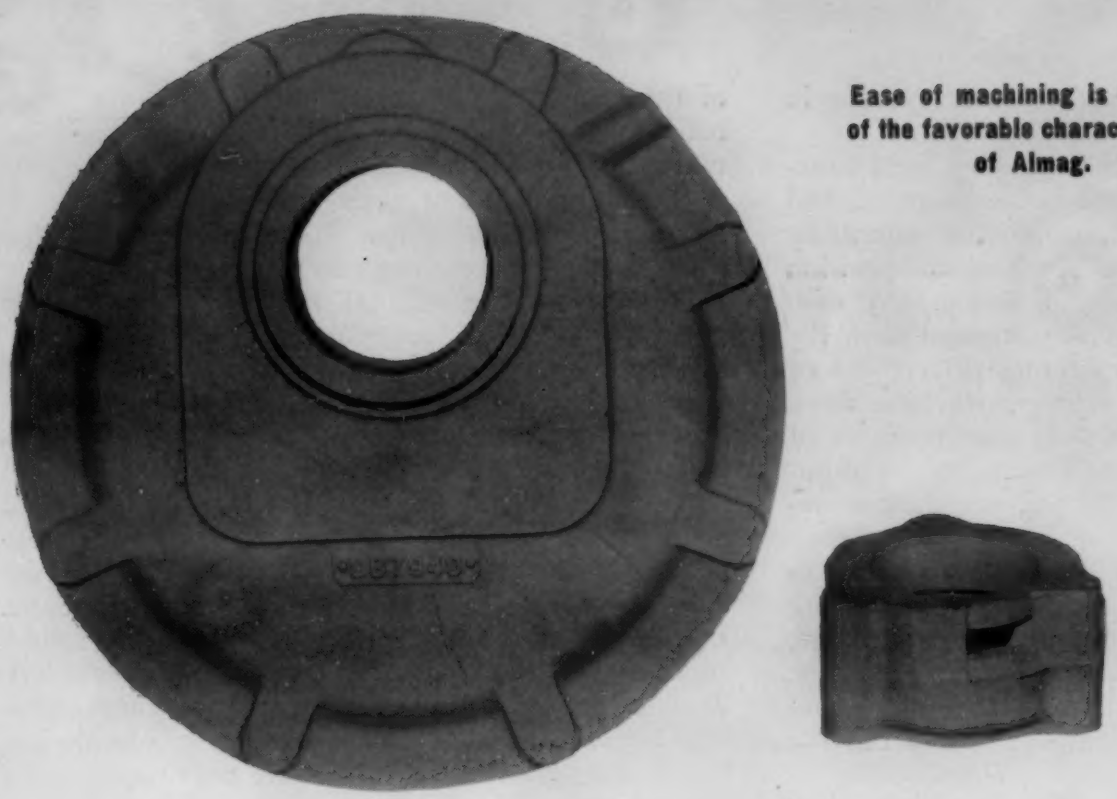
Experimental work with this cast alloy was begun by Hugh S. Cooper of Cooper Metallurgical Laboratories, during the latter days of the war, using small additions of beryllium. Even before the effect of additions of beryllium was studied, it had been observed that some heats of the aluminum-magnesium alloy possessed better strength properties than others. By careful checks of density, it was decided that these superior heats had less gas porosity than the others. To eliminate porosity, degassing of the molten metal was found to be necessary, and boron trichloride gas, blown through the melt just before pouring, gave the desired results. The occasional 53,000 psi. heat became commonplace. However, it could not be produced to order. Addition of beryllium was found to suppress the bulk segregation of magnesium, and so to minimize the zones of weakness that had resulted from such segregation. The final result was to bring the heats closer to the predictable maximum strength.

The alloy solidifies at 1140 F, and shows a definite slowing of the cooling rate at about 1170 F. It is usually poured at about 1220 to 1250 F. Pouring temperature is not critical as regards strength properties of the alloy, tests show.

In melting and pouring the metal a simple technique is all that is required, but this must be followed closely. Melting in clay graphite crucibles is recommended to avoid silicon pickup. No fluid flux need be used. Heat is applied until the metal is molten, and the gas or oil is then stopped. The temperature will go to 1360 to 1400 F. As the temperature drops to about 1300 F, boron trichloride is blown into the melt at as rapid a rate as possible, allowing 1 min. per 30 lb. of metal. A cylinder of gas with a length of iron pipe attached so as to permit the pipe to extend into the molten metal comprises the entire degassing equipment.

About 5 to 15 min. after degassing the pouring temperature will have been reached. The metal is poured in the usual way, into green sand or dry sand molds. Ordinary molding sand is used, and no inhibitor need be added. When sections greater than

With a minimum tensile of about 60,000 psi., the new casting alloy can be used for many heavy-duty parts.



Ease of machining is but one of the favorable characteristics of Almag.

1-in. in thickness are to be cast, an inhibitor might be useful, and in such case 5% boric acid or any standard inhibitor can be used. The metal may show yellowish or bluish oxidation streaks when cast in dry sand, or on surfaces in contact with cores, but the discoloration is shallow and easily removed.

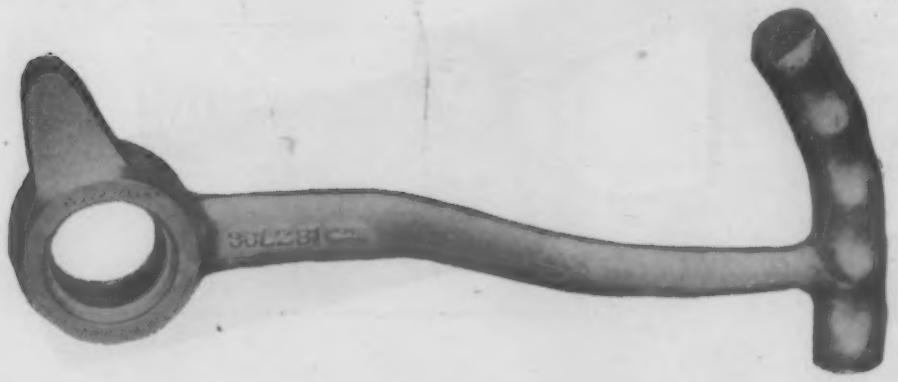
Gates and risers should be in the ratio of 3 to 1 to the weight of the casting. With very large castings this ratio has been cut to 2 to 1, while for small or difficult forms it may go as high as 6 to 1. Maintenance of adequate ratios is the best insurance against shrinkage porosity in the castings.

The hardening process is not yet thoroughly understood. It shows many points of difference from the solution-and-precipitation hardening of other aluminum alloys, and no satisfactory theory has yet been advanced to reconcile the contradictions. A procedure has been worked out to give results in higher strength properties, however, and it closely resembles the treatments used for solution-and-precipitation hardening.

The castings are heated in a furnace at 820 F for 4 hr. for pieces of ordinary thickness. Three hours at temperature is the absolute minimum, and 4 hr. need be exceeded only for castings having exceptionally thick sections. The parts are then quenched at once in boiling salt solution, containing about 20 to 25% of common salt to raise its boiling point to about 225 to 230 F. Quenching oil held at 260 to 300 F, or a strong blast of cold air, will achieve the same results, but the salt solution is the simplest medium for quenching.

Maximum strength is developed during aging subsequent to the heat treatment. So far, no method has been found that will accelerate the aging process. Physical properties gradually improve during a period of about six weeks after heat treatment, whether held at room temperature or at elevated temperatures, and the rate seems to be constant regardless of temperature. A more gradual increase of strength continues for about six months. As the alloy has been produced for less than a year, results that are thoroughly representative of the alloy being produced by present methods are not available for regular intervals covering more than six months. These results indicate a levelling off after six months aging.

The change in properties during the aging period is not uniform for all of those properties. Tensile strength increases rather rapidly for about four to six weeks, then continues to increase at a slower rate. The yield point is raised decidedly, and here the rate of change may remain high for a longer period than is the case with the tensile strength. The elongation likewise may show a considerable part of its decrease during the latter part of the aging process.



The alloy requires no finishing, but can be anodized if color is desired.

Some of the test results illustrating the results of aging are as follows:

	Tensile Str., Psi.	Yield Str., Psi.	Elongation, %
Sample I			
As quenched	57,400	29,600	23.9
15 days	57,300	—	17.0
30 days	59,450	32,900	17.2
60 days	60,030	33,250	14.3
Sample II			
As quenched	53,600	30,200	17.8
30 days	57,500	33,500	16.4
60 days	58,930	34,000	16.1
90 days	60,270	36,000	14.5
Sample III			
As quenched	57,200	27,700	29.0
120 days	63,800	39,500	15.5
150 days	62,900	41,600	11.1

Occasional heats will develop high strength more quickly than the average. One such lot was tested before shipment recently, and a tensile strength of about 57,500 psi. in the "as quenched" condition was indicated. A month later a strength of 62,450 psi. was obtained in tests by the purchaser.

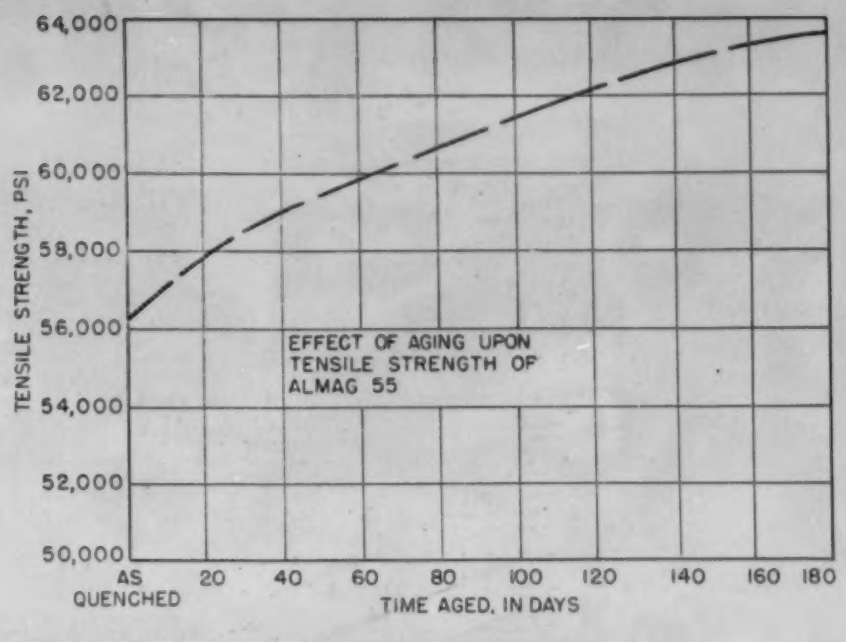
Present results seem to show that the designating of the new alloys as Almag 55 and Almag 35 has been over-conservative. The 55,000-psi. minimum specified for the former could be safely raised to 57,000 or 58,000 psi., as the heats after aging show 60,000 to 65,000 psi. tensile strength. A 38,000 to 40,000 psi. minimum could be specified for the "35" alloy.

Data are insufficient to warrant setting average values for all the properties of the new alloy. Impact values are high for an aluminum alloy, and endurance tests give exceptional values also. The combination of properties that will determine its uses, however, is high tensile strength with high elongation, excellent corrosion resistance, and low specific gravity.

While primarily a sand casting alloy, the new material has given good results when cast in plaster. It has also been die cast in sections as thin as $^1/_{32}$ in. Some experimental results seem to hold out the possibility of its being used for permanent mold casting also.

Machining can be accomplished without difficulty. As the Brinell hardness of the quenched and aged pieces is about 100 when measured with 500-kg. load and 10-mm. ball, and cutting is best done at rather high speeds, use of carbide-tipped tools is recommended. The alloy takes a high polish, or can be anodized and painted, or anodized and dyed.

While weldability is another property that has not yet been carefully studied in connection with the alloy, there are indications that argon welding with a 400-amp. machine will give satisfactory results.



Physical properties increase during a six-month period.

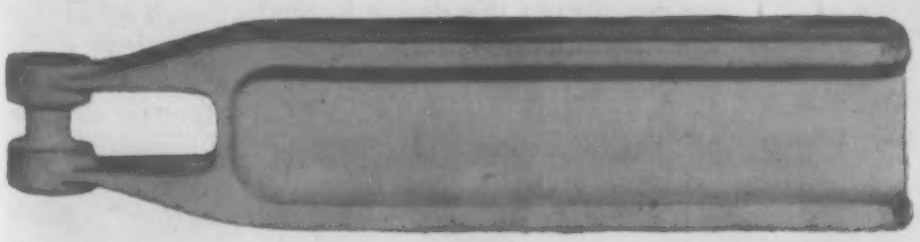
The light alloy is expensive. A broad minimum estimate of cost per pound of castings would be about $1.50. The low yield in the foundry, due to the extensive gating and risering required, and the high cost of several of the constituents of the alloy, make it unlikely that it will become cheap in the near future, but officials of Acme Aluminum Alloys believe prices can be lowered after volume has been increased.

One user reports that physical properties are lowered by exposure to elevated temperatures. As this is the case with other heat treatable aluminum alloys also, it is not a disadvantage specific to this alloy.

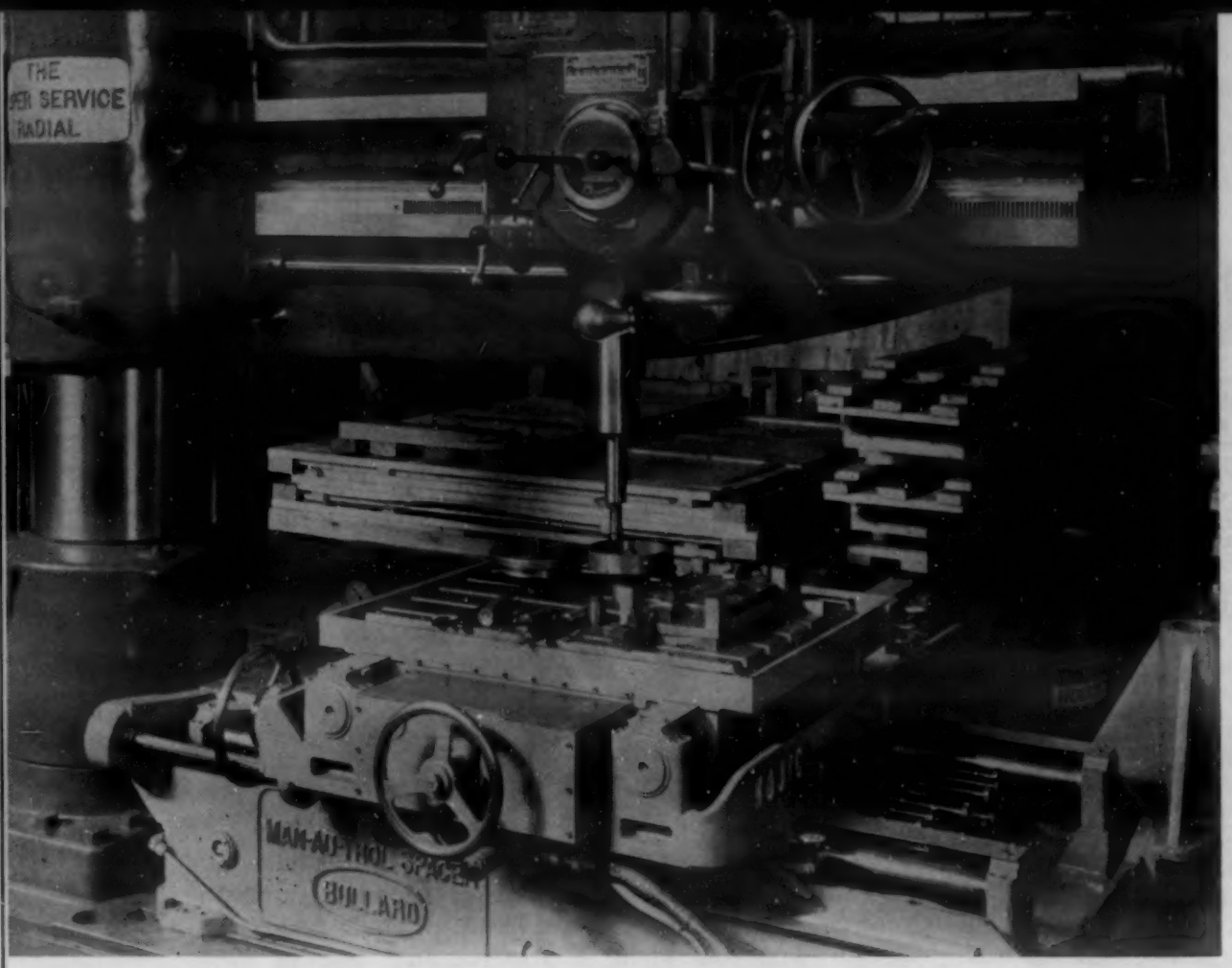
Although the high strength alloy is less than a year old, it has already won for itself a place in the roster of industrial materials. The biggest purchaser is the United States Navy. Large castings for ordnance items, weighing 600 to 800 lb., are made in the alloy because a combination of light weight and high impact resistance is required. Aircraft applications requiring high strength and light weight are also using the metal. Marine engines are another use.

An interesting example of how the combination of properties works is found in a casting for a hydraulic jack. The body casting is required to withstand high pressure, and at the same time light weight is advantageous because the jack, intended for construction work, must be transported about the country. When produced in malleable iron, the jack weighed 105 lb. The same parts cast in the strong aluminum alloy permitted weight reduction to 47 lb., while giving adequate strength for the service desired.

The metal is available in ingot form from the producer, or can be had cast to shape. Any foundry that will follow the prescribed procedure for melting and casting the alloy can turn out successful castings, the engineers of Acme state.



While primarily for sand casting the new alloy has been cast in plaster with good results.



In this set-up on the Man-Au-Trol, three small parts are held on the unit's table to further simplify hole spacing.

AN OUTSTANDING **1946** DEVELOPMENT IN

MACHINING

A New Method of Spacing for Hole Drilling

by T. C. Du MOND, *Managing Editor,* MATERIALS & METHODS

DESPITE THE FACT that the drilling of holes is one of the most common operations in any metal-working plant, there has been little progress in properly locating holes over the entire period in which drilling machines have been used. Now, however, a recently announced development promises to save countless hours and untold dollars in accurately locating holes. Savings will result from the elimination of costly jigs and because the entire family of drilling operations—drilling, boring, reaming, tapping—can be performed in a logical manner.

The Bullard Co., Bridgeport, Conn., is responsible for the advance in drilling through its Man-Au-Trol, a device that provides the automatic spacing of holes according to a predetermined layout. At present there are two sizes of this device in production, a small unit which is suitable for applications on sensitive drills, and a larger model which is designed to be used on 4-, 5- and 6-ft. radial drills. In the interest of simplicity, this article will concern itself primarily with the larger unit.

Some idea as to the potential savings possible

through the use of Man-Au-Trol spacers can be obtained from the fact that in the Bullard plant alone more than $350,000 in drill jigs and special tools has been declared scrap. Additional evidence can be had in the fact that by using the first models of this device in the production of their successors it was not necessary to take the time to make jigs for hole drilling. Bullard officials are quick to point out that while the spacers can be used for the vast majority of drilling jobs, it cannot be used for all.

Accuracies comparable to those attained on a jig borer are easily provided by the spacers at production line speeds. To demonstrate the unit's accuracy, it was used to space a pattern of four holes in a ⅝-in. thick piece of steel. With one piece finished, the same pattern was drilled independently in another piece of steel the same size. One steel plate was placed on top of the other and four steel pins, super-finished to 0.0005 in. less than the holes, were inserted. The holes in both pieces matched perfectly. All possible combinations of holes were tested and each hole proved highly satisfactory in relation to each of the others.

What the Spacer Is

Basically, the spacer is a table mounted on a saddle and base. This unit is mounted on the radial drill base and connected to a hydraulic system used to control movement of the table and saddle in locating the work piece under the drill spindle. When using a Man-Au-Trol spacer on a radial drill, the drill spindle remains stationary and the work is moved automatically for each new hole location. A total of 260 holes can be located in one setting of the spacer without moving the workpiece.

For added control over accuracy, the drill arm is made rigid by means of an outboard support which is attached to the right hand corner of the drill bed. Another bracket attached to the drill arm is designed to encircle the support bar in such a way as to permit the drill arm to be raised and lowered. The bur bracket can be opened so the drill arm can be moved out of the way, when loading and unloading heavy work, and then returned to its exact position.

Although the large spacer is known as the 30 by 20 in. size, because these are the limits of longitudinal and transverse table and saddle travel, the table itself is 32 by 40 in. Work larger in size than these dimensions can be handled, although holes outside the 20 by 30 in. area require that the work be reset.

How the Spacer Works

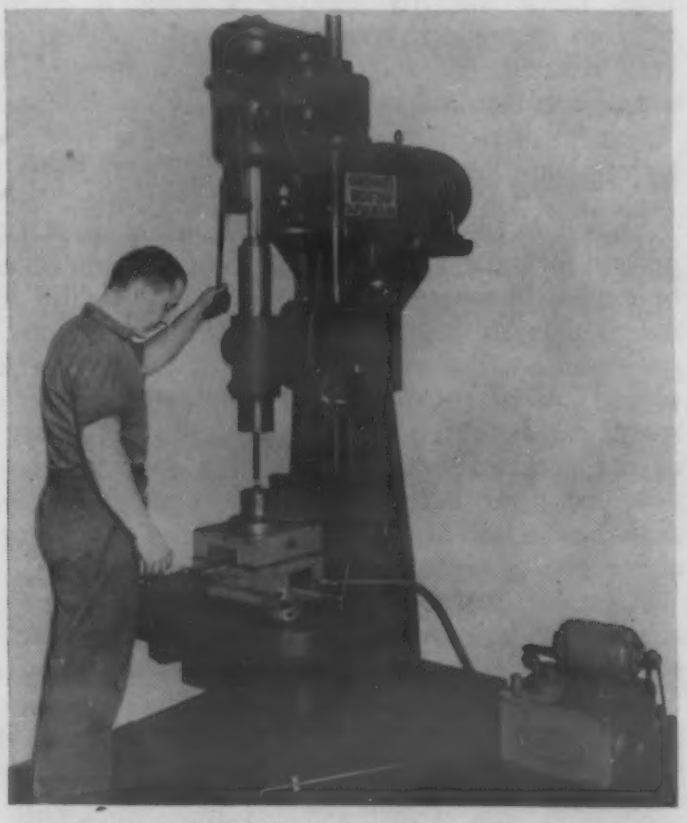
Saddle movement of the spacer, which is always longitudinal, is 30 in., while the table movement—always transverse—is 20 in., providing the 20 by 30 drilling area referred to previously as being available for any one setting of work. The 260 holes which can be located in one setting of the spacer are provided by 20 separate stops in longitudinal travel and 13 transverse stops. The combination of 20 stops times 13 stops equals the total of 260 different spacings.

Movement of the table is directed by a transverse dial, located next to the operator, which can be instantly set to establish different hydraulic circuits such that the table will move transversely in either direction to a predetermined position. This dial is marked with stops lettered from A through M.

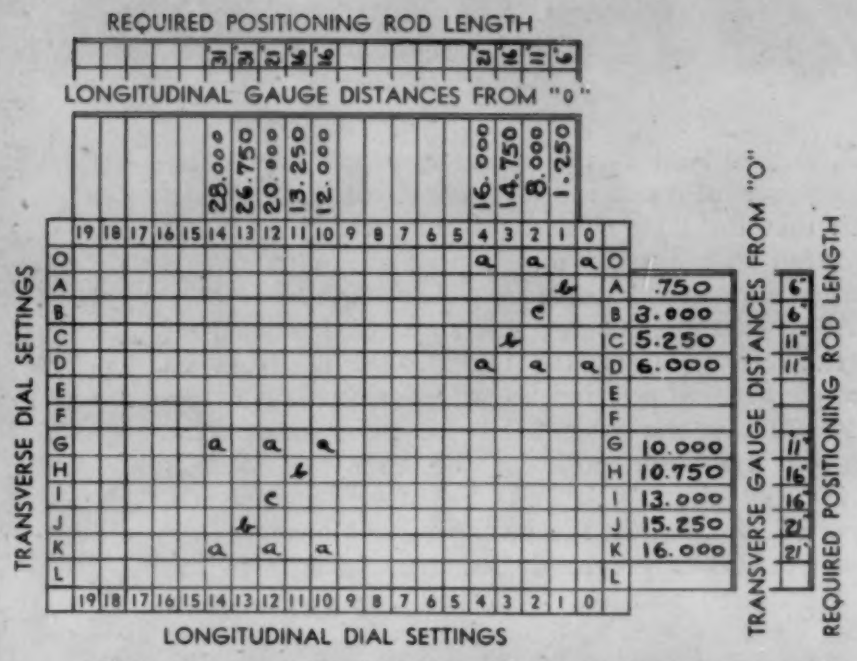
As an example, assume that stop "C" has been set to transversely locate the table 8.000 in. from its extreme forward position. Now, whenever it is necessary to locate the table 8.000 in. from its extreme forward transverse position, the transverse dial is moved to position "C." The table will then move at a speed of 10 f.p.m. in the proper direction, regardless of where it was previously located, and stop in the exact required position. Once the proper position is located, the table is hydraulically locked against any force resulting from the drilling operation.

Similarly, there is a longitudinal dial, with numbers from 1 to 20, located to the left of the operator. This dial can be set to establish hydraulic circuits such that the saddle will move longitudinally to its predetermined position. Thus, if position "3" is 4.000 in. to the front of the extreme rear position, when the longitudinal dial is turned to "3," the table will move so that this ordinate is located directly under the machine spindle.

Thus, once the adjustable stops have been set to correspond to the ordinates of the various holes to be drilled, the piece may be moved longitudinally and transversely to its exact position by turning the longitudinal and transverse dials to select the proper stops. Therefore, the table is controlled entirely by the two dials and the positions of the table are automatically selected by moving these dials to the numerical or



Small size spacers help to speed work done on sensitive and other fixed-spindle drilling machines.



This is one suggested chart for setting up a large spacer which is to locate a piece requiring 9 holes. All information for the set-up was obtained from an engineering drawing of the part.

alphabetical position desired. Extremely accurate setting of the dials themselves is not necessary, since the dial stops serve merely to actuate the proper hydraulic circuit.

In the underworks of the spacer there is one hydraulic cylinder for each longitudinal and transverse stop. Thus, if ten cylinders were used to provide stops in each direction, they would control 100 positions. Force from a balanced master cylinder, working in conjunction with the force of an active cylinder, provides a smooth, rapid motion from one location to another and locks the table against its stop. Rods are provided with the spacer so that the required travel distances can be attained in setting the cylinders. Rods are available in lengths from 6 to 31 in. in steps of 5 in. Intermediate spacing is provided through micrometer control at the end of each cylinder. Accuracy of such spacing is attained through use of accurate end measuring rods.

Determining Spacer Settings

Shown in an accompanying illustration is one suggestion for a chart to be used in locating eight holes to be drilled in a steel plate. This is but one of many means that can be used to set down instructions for positioning cylinders. Regardless of the method employed, all of the information necessary to set the spacer can be obtained from an engineering drawing of the part to be drilled. After a spacing chart is provided, a work chart is made up for the operator showing the hole size, number and types of operations, and depth of hole, thread or chamfer for each hole.

After required stops have been determined, rods of appropriate length are selected and placed in the positioning cylinder corresponding with the stop letter (transverse) or number (longitudinal). Final exact location is then reached through the micrometer control adjusted to the measuring rods.

In tests to determine possible economies with the Man-Au-Trol spacer, Bullard used it in spacing for drilling, reaming, counter-boring and tapping parts for other Bullard machines. One lot of 74 pieces required more than 70 hr. for drilling when a jig was used. Over 10 hr. were saved with the spacer. The jig, which has been eliminated, cost $350 to make. A lot of 134 of another piece formerly required 20 hr. to drill. The spacer saved 4 hr., plus the cost of a jig —$75. Set-up times were included in all tests.

Advantages of Spacer Method

On the basis of work done plus knowledge gained by tests conducted in the Bullard plant, the following advantages can be expected through the use of spacers:

(1) Jigs will virtually be eliminated. First, the cost of engineering and production time and labor, as well as materials, to provide jigs is saved. Second, jobs can be put into production without the costly delays which often occur waiting for jigs to be made. In addition, there will be no expense such as is normally encountered in inspecting, maintaining and repairing jigs, to say nothing of the elimination of record keeping in connection with the jigs normally used.

(2) Fast and flexible set-up. Unless jigs are always at hand, the unit can generally be set and placed in operation in the time normally required to locate and setup jigs.

(3) Less lost time in drilling holes. Since the drill arm remains in one place, there is no problem of relocating the arm for each hole and no lost time in centering the spindle in the jig opening.

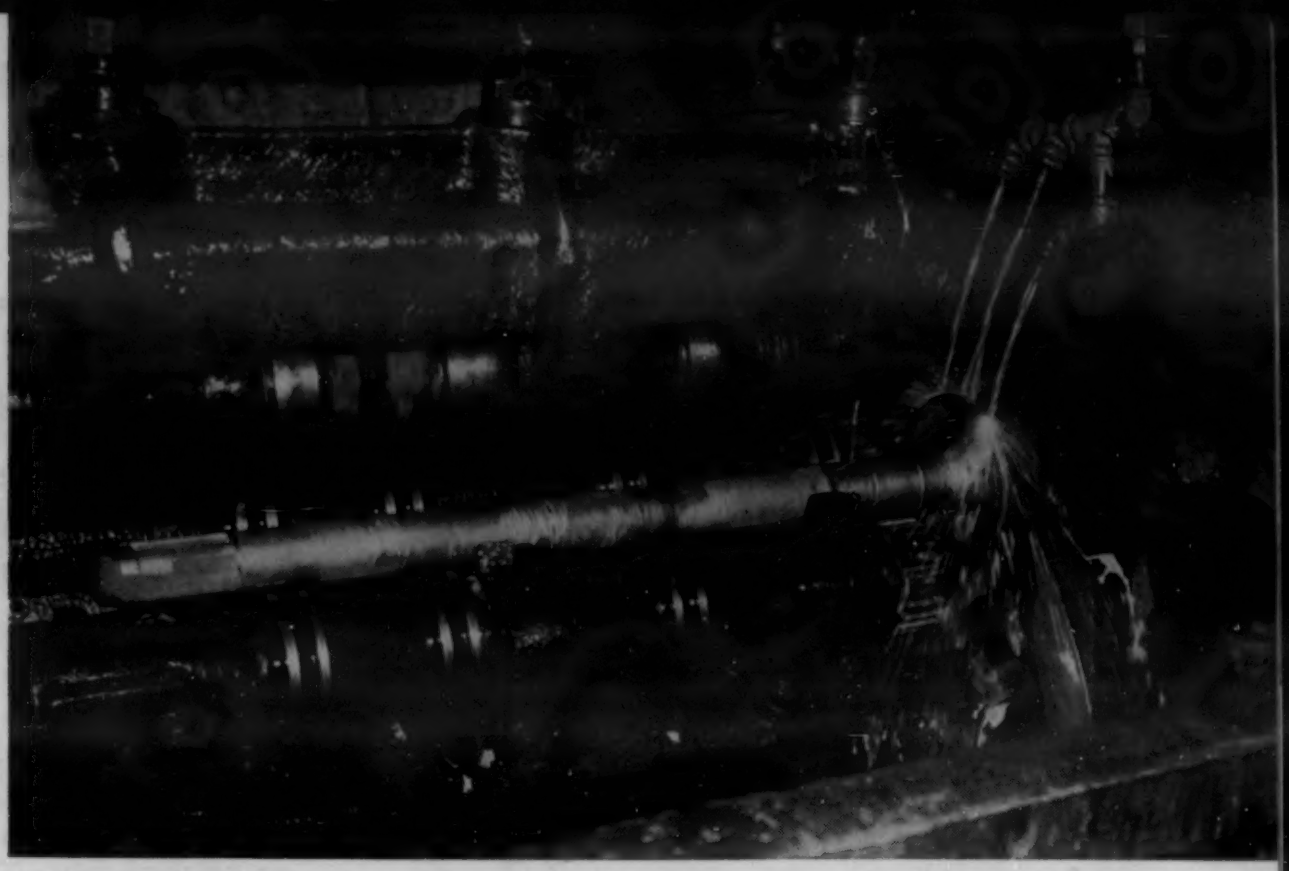
(4) More logical sequence of operations. Because of the ease of shifting from one setting to another, it is faster and easier to do all work required of any single tool regardless of hole position on the work piece, thus saving time normally wasted making two or three tool changes on each hole. Drilling and kindred operations are reduced to a true operational basis, whereby each functional increment of a job is completed before the next step is undertaken. By so handling this work numerous tool, feed and spindle changes are avoided.

(5) Worker fatigue is reduced. Constant moving and relocating of the drill arm is not necessary since the work is moved automatically.

(6) Standard rates of time are more easily determined for drilling jobs. Since the spacer moves at a constant rate of 10 f.p.m., time measurements are easily made. All moves are measurable.

The smallest Man-Au-Trol spacer has a table area of 9½ by 11⅜ in. and a table movement of 4 in. in the transverse and longitudinal directions. Table movement restricts the drilling area at one setting of the work to a space 4 by 4 in. Since there are ten stops each for longitudinal and transverse travel, 100 holes can be positioned at one setting. This small unit does not require positioning rods as does the large model, since all spacing is provided through nine adjusting screws for each direction. The tenth position in each direction is fixed.

While it is too soon to predict that the drill jig is on its way to extinction, it is safe to say that from now on said drill jig will be of considerably less importance than it has been heretofore.



A caustic spray cools the flange of a truck axle before the entire piece is dipped into the solution. (All photos courtesy Ford Motor Co.)

Caustic Soda as a Quenching Medium for Steel

by **KENNETH ROSE,** *Engineering Editor,* MATERIALS & METHODS

QUENCHING MEDIA FOR hardening steel can include a rather long list of materials, starting with air and continuing through water and various aqueous solutions, many types of oils, molten salts, and finally to molten metals. The great bulk of the steel quenching done, however, utilizes air, water, oil or molten salt as the medium for withdrawing heat from the steel—so much so that steels are frequently classified as air-hardening, water-hardening, or oil-hardening.

Water has many obvious advantages for the quenching of shallow-hardening steels, which require rapid withdrawal of heat. It is quite cheap, easily available, presents no difficult handling problems, can be cooled in simple spray towers, and suffers no deterioration in use. Disposal is simple also. The rate of heat withdrawal is slower than might be desired, however, for steels of this class, even under laboratory conditions and with laboratory-size specimens. When the work is done in the plant, with surface scaling of the parts being quenched presenting a new problem, and with agitation frequently inadequate, results fall short of those obtained in the laboratory, and use of another medium may be helpful.

Dilute caustic soda solutions have provided an answer in some heat treating departments. At Park Drop Forge Co., Cleveland, caustic quenching has replaced water quenching entirely, and has given satisfactory results with a variety of forged parts ranging from small pieces handled in baskets to 2800-lb. Diesel locomotive crankshafts. Ford Motor Co. uses caustic quenching widely in the heat treatment of water-hardening steels, and reports more uniform hardening as one of the results.

AN OUTSTANDING 1946 DEVELOPMENT IN HEAT TREATING

After being removed from a continuous furnace, axles are quenched in a caustic solution.

The caustic solutions offer the following advantages in steel quenching:

(1) Most rapid heat withdrawal rate of any of the industrial quenching media.
(2) More uniform results—less danger of soft spots on the surface of the work.
(3) Relatively low cost.

The primary reason for use of caustic soda solutions is the high rate of cooling it provides. Caustic soda affords the highest velocity of heat withdrawal of any of the quenching media used commercially. Liquid air and lithium chloride solution, with higher rates, have not yet found industrial application in this field. Caustic soda solutions will withdraw heat from steel at slightly more than twice the rate possible with water at room temperature, when the steel is being quenched from the usual range of hardening temperatures.

Hardening More Uniform

Hardening is more uniform with the caustic solutions than with water. One reason is the scale-removing ability of the caustic, by which the surface of the work is brought into uniform contact with the cooling solution, without interference from patches of adhering oxide. Scale patches may appear to remain on the work after caustic quenching, but they are thin, loosely adhering, and friable. A jet of water, or of caustic solution, is all that is needed to remove the remaining scale in most cases. Another reason for the greater uniformity of surface hardness is that less vapor formation occurs in the caustic solutions, due to their higher surface tension. The "vapor blanketing" of the workpiece, one of the causes of slower heat conduction as well as irregular cooling of the surface, is minimized.

Another result of this increased scale removal and decreased vapor formation is the quicker "bite" of caustic solutions. Rapid withdrawal of heat from the work seems to begin almost immediately upon immersion in the quenching medium.

Caustic soda solutions, while more costly than water, are not high-priced media. Commercial sodium hydroxide, or caustic soda, also called lye, costs about 2 to 4c per lb. in quantity. The solutions used are dilute, so that total material cost is not high. Solutions most commonly used range from 2.5 to about 6.5% caustic soda, although 10% concentrations and higher have been studied.

Some of the disadvantages of caustic soda solutions as quenching media are:

(1) Caustic soda, solid or in solution, deteriorates upon contact with air.
(2) The solutions are somewhat inconvenient to handle.
(3) A time quench should be used for most work.

The tendency of caustic soda to take up carbon dioxide from the air, with formation of sodium carbonate, prevents the use of spray towers for cooling the liquid, as would be the customary procedure for water. It also makes inadvisable the agitation of the liquid in the quench tank by bubbling compressed air up through it. These difficulties are not as important as might seem at first glance, however. Deterioration of the solutions is rather slower than might be imagined, and, as the sodium carbonate formed has a high cooling rate also, the net result over short periods is little different from that obtained with the fresh solution.

Cooling is usually accomplished by using a heat exchanger, with water as the other liquid. The water may then be cooled by using the spray tower, as would be the case in water quenching.

Because the caustic soda solutions maintain a fairly high rate of cooling even at lower temperatures, the work is usually withdrawn from the quench before it has cooled below the lower critical point, and the cooling is continued in air or other medium giving a slower rate of heat withdrawal. Close control of the temperature at which the work is withdrawn is not necessary; a length of time, determined by trial, for immersion that will cool the parts below red heat is sufficient.

Use of caustic soda solution requires that precautions be taken for protection of the workmen from splashing of the liquid. The danger is inconsequential—certainly no greater than that from salt baths—but it is well to have a bottle of vinegar or other weak acid nearby to neutralize any caustic that may spatter onto the workmen's hands or faces.

Strong caustic soda solutions slowly will dissolve iron oxide, but will not affect the metal itself. Even the weak solutions tend to find leaks in threaded pipe connections, or in metal-to-metal joints that are riveted or bolted. The condition is not serious, but may give the installation a messy appearance.

It will be seen that these solutions have properties that especially recommend them for quenching forgings. The fairly heavy scale that builds up on the surface of pieces during forging acts to give uneven hardening of the surface, and especially to prevent proper hardening of the work at small-radius fillets and similar areas. The importance of precisely these locations from the standpoint of fatigue resistance is now being recognized. When the hardening procedure includes quenching in caustic solution, the scale-removing property of the liquid, combined with the exploding of the scale as the hot metal strikes the cold solution, gives greatly improved results.

Solution Concentrations

Concentration of the solution seems to be more important from the standpoint of scale removal than because of any variation in rate of cooling. H. J. French, in his book "The Quenching of Steels," points out that apparently a wide range of concentrations gives substantially the same result so far as cooling rate is concerned. His figures are:

% NaOH by Wt.	Cooling Rate in Degrees F per Sec.
0	248-284
2.5	419
5.0	428
11.5	428
16.5	437

The test piece was a ½-in. cylindrical bar of steel of 0.95% carbon content, and the rates were determined at 1328 F.

The more concentrated caustic solutions have higher dissolving power as far as the oxide scale is concerned, but show lessened ability to explode the scale from the work, due to the lessened formation of vapor. The best balance seems to be struck with concentrations in the 3 to 6% range, and these are the solutions that are used commercially.

At Park Drop Forge Co., a considerable tonnage of forgings must be quenched each day. They are of plain carbon steels, and of 4140 and 4340 steels also, in a variety of parts ranging in size from 8-in. dia. to about 2-in. dia. The problem of water for quenching, in sufficient quantity and at a proper temperature, became acute in summer, and the building of additional spray towers did not seem to be the best solution.

Use of caustic soda solution for quenching was adopted, and it was found that, because of its much higher rate of cooling, hardening was adequate even when the temperature of the solution rose higher than could have been permitted with water. So effective was the caustic that it was decided to continue its use during the winter. It has been used ever since.

The solution is used in a concentration of 4 to 6% caustic soda, and the same stock solution is used for all quenching throughout the plant. It is cooled in heat exchangers, with water as the heat-withdrawing liquid, and the water is then cooled in spray towers.

Caustic soda has been especially effective in obtaining proper quenching in corners and fillets of such pieces as crankshafts. Continuous recirculation is used to give the necessary agitation of the quenching medium in the quench tanks. All excessive contact with air is avoided.

Concentration of caustic soda in the quenching solutions at Ford Motor Co. is held to 7 to 10 deg. Baume, or about 4.5 to 6.5% caustic by weight. Time quenches are used, and it is general practice to withdraw the work from the quench at temperatures of 500 to 600 F if the workpiece is of uniform section, or, if nonuniform, as soon as the core has cooled sufficiently so that it will not temper the hardened sections by conduction of heat.

The quenching solutions are cooled in heat exchangers, and the water, of which there is no scarcity, is run to the sewers.

Here an automobile axle, rotating in a special fixture, is immersed in a caustic soda solution. Simultaneously a second axle is removed from the bath.

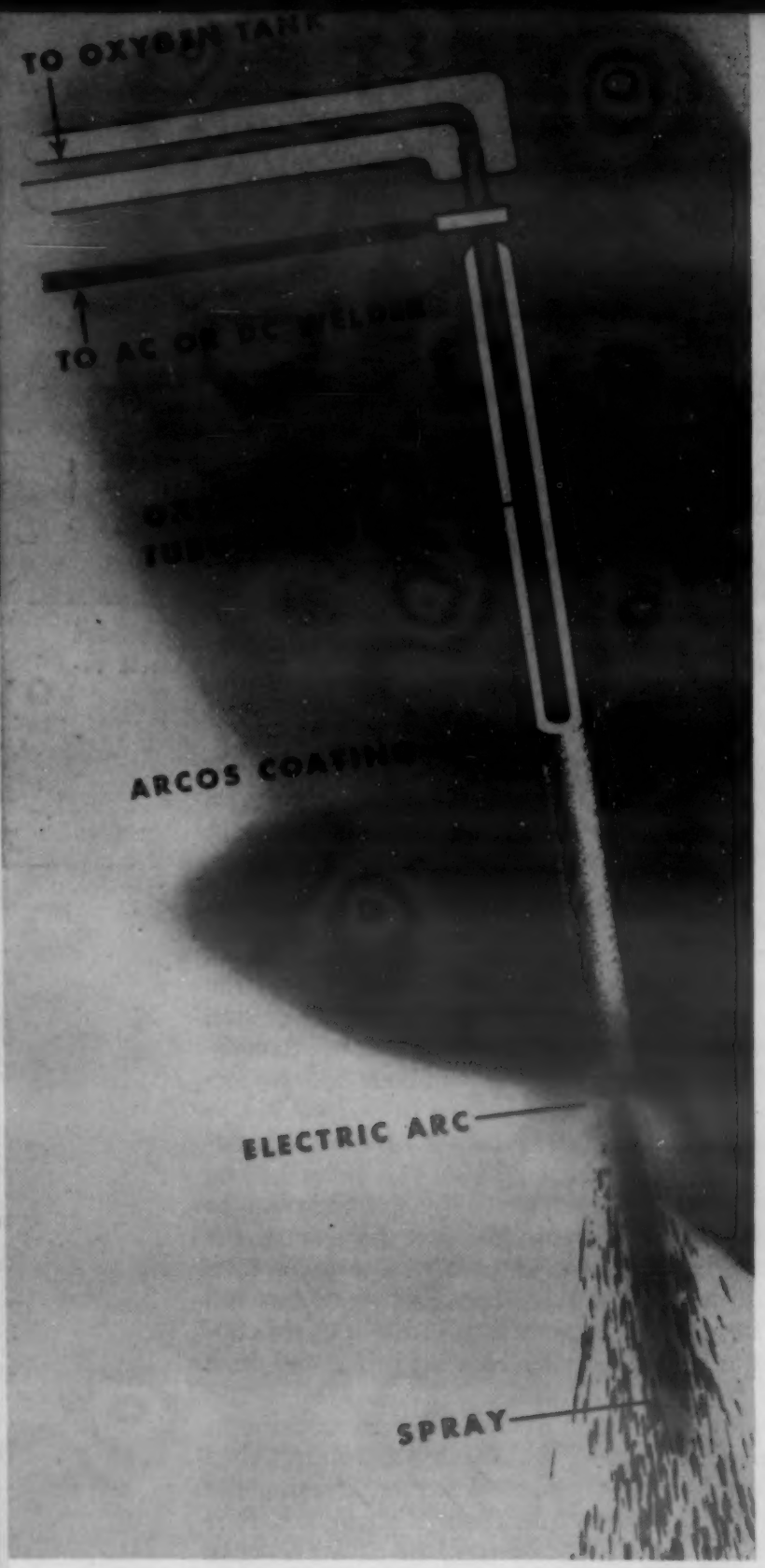
A passenger car axle is one of the parts that is caustic quenched. At the time the axle is hardened, a small pinion has been keyed on at one end, and the other has been tapered. The pinion is finish size, while the tapered end requires a key seat. Accordingly, the gear end is hardened to about 532 to 555 Brinell, and the tapered end is held to 302 to 364 to permit easy machining. The center of the shaft develops a hardness of about 340 to 440 Brinell. The differential hardness is achieved by a tempering in which a higher heat is maintained at the side of the furnace carrying the tapered ends of the axles than is developed in the gear side. The axles move through the draw furnace on supports attached to a chain conveyor, and are held parallel to each other and in a horizontal position at all times.

The quenching is done in a two-fixture machine in which the axle is rotated rapidly as it is immersed in the caustic solution. The second fixture, carrying the piece that has now been quenched to about 700 F, is simultaneously rotated out of the bath and the work is removed. While a straightening operation follows for those pieces that have warped, there is less distortion than quenching without the fixtures, according to the heat treat engineers. A carbon steel approximately equivalent to S.A.E. 1045 is used.

A truck and tractor axle, having a flange at one end of a shaft, affords the same problem in nonuniform section. In this case the spindle is revolved as a jet of caustic solution plays on the periphery of the flange, chilling it and preventing cracking when the entire piece is quenched. A steel approximating S.A.E. 1045 is used here also.

Connecting rods are made of a steel resembling S.A.E. 1040, but with a manganese content of about 0.70 to 0.90%. It is caustic quenched in a belt conveyor, and a hardness of about 512 to 555 Brinell is produced in the fully hardened piece. A draw reduces this to 286 to 321 Brinell.

Front wheel spindles, swaybars, front axles for passenger cars, and many other parts are also caustic quenched. Caustic soda solution has replaced water everywhere that the job warrants a production setup, according to company officials.



This schematic drawing shows how the Oxyarc process of metal cutting operates.

AN OUTSTANDING
1946
DEVELOPMENT IN

WELDING & CUTTING

New Oxygen-Arc Process

by **H. R. CLAUSER,** *Associate Editor,* MATERIALS & METHODS

THE CUTTING OF ALLOY STEELS and nonferrous metals has always been an annoying problem to engineers and to production and shop men in the metalworking field. On section thicknesses and parts where shearing cannot be used, mechanical means, such as drilling, chipping and sawing, are slow, high-cost operations. The oxyacetylene cutting process, using special techniques, and the carbon or metallic electrode method have only limited application for cutting stainless steels; they are also slow, expensive and give a very rough cut. Because of these difficulties, metal fabricators have often avoided using alloy steels and nonferrous metals in applications where these materials would have the most desirable service characteristics.

Within the last few months, the Arcos Corp. has introduced a cutting method, known as the Oxyarc process, that eliminates most of the difficulties encountered in cutting oxidation-resistant materials. The process makes possible the hand cutting of all the

Here the Oxyarc process is being used to cut a piece of stainless steel.

for Cutting Ferrous and Nonferrous Alloys

metals commonly used for fabricated parts. The metals that can be cut include the stainless steels as well as other alloy steels, nonferrous metals, cast iron, and mild steel.

The process was first developed by an Arcos Corp. affiliate in Belgium and put into practical use there for cutting mild steel during the war. In this country the fundamental idea was derived from the Navy's underwater cutting method that employs an electric arc-oxygen stream.

In the Oxyarc process the metal is cut by the use of a fine point concentration of heat generated by an electric arc and a stream of oxygen. The arc is established between a coated tubular rod (called by Arcos the Oxycuttend rod) and the metal to be cut. The high temperature arc and oxygen sever the metal by an oxidation reaction and melting. The rod and its coating are consumed by oxidation during the process of cutting.

The equipment required for the process includes a special Oxyarc holder, bottled oxygen, an arc welder, and the tubular coated rod. The present rod is 18 in. long, 3/16 in. outside dia., and is made of mild steel. Through the center of its length is a fine hole for the flow of the oxygen stream. The rod coating helps maintain arc stability and forms a small crucible which directs and confines the arc; it also acts as an insulator to prevent striking an arc at any other point except at the end, and serves as an "insulated heel" on which to drag the rod along the line of cut.

The rod is held by the special holder, which in many respects is similar to a welding electrode holder. It is specially designed for quick removal of stub ends and the insertion of new rods. The current and oxygen pass through the holder to the rod; the stream of oxygen through the holder keeps it cool. The flow is controlled by a valve built into the holder and triggered by the operator. This same holder may also be used for welding. Either an AC or DC arc welder can be used. Both work equally well, and there is no

In this illustration a piece of alloy steel is about to be pierced. Details of rod holder construction are readily seen.

essential difference between the two in the operating characteristics.

No special skill is required to cut with this equipment. To start the cut, an arc is struck between the rod and the metal to be severed. Oxygen is supplied and the rod is then touched against the metal and the contact is maintained as the rod is dragged along the line of cut. In piercing operations the rod is actually pushed through the hole as the metal is pierced. In cutting heavy sections where the metal cannot be severed by dragging the rod, a "sawing" action is used to completely penetrate the thickness. Cutting can be done in the overhead as well as in the vertical and downhand positions.

What the Process Can Do

As was mentioned previously, the Oxyarc process can be used to cut a wide variety of metals, and until now Arcos has encountered no alloy which cannot be cut by the process. Perhaps its widest application promises to be in the cutting of alloy steels, particularly the stainless steels. Other metals that have been successfully cut include nickel, Monel, cupro-nickel, copper and its alloys, aluminum, cast iron and plain carbon steel. The cutting of copper alloys is made possible by the high temperature produced and the concentration of heat in a very small area so that the cut is made before the heat is dissipated through the material.

Clad materials, such as stainless and nickel clad steels, can also be cut. The cutting operation can be performed from either side; however, a smoother cut is obtained when the cut is made from the mild steel side.

At the present time, the process can be used for cutting the materials mentioned above in thicknesses up to 3 in., and for piercing up to 12 in. It is possible to cut sections thicker than 3 in., but the greatly increased rod consumption makes it uneconomical. It is expected that future development work will broaden the field of application by making it economical to cut the heavier sections.

A very important factor to consider in cutting metals, especially corrosion-resistant alloys like the stainless steels, is the effect of the cutting on the corrosion resistant properties near and along the cut edge. Tests by Arcos indicate that there are no harmful effects caused by carbide precipitation adjacent to the cut edge. An investigation of the cut edge of a sample of austenitic stainless steel, Type 304, revealed a thin surface zone 0.02 in. thick. The surface layer of this zone was 0.015 in. and contained oxide inclusions. The remainder of the zone, under this surface layer, contained ferrite islands and precipitated carbides. The corrosion resistance of the as-cut surface as measured by a 65% nitric acid solution was slightly lower than that of the normal plate; but from a practical standpoint there was no decrease in corrosion resistance.

Visual examination of specimens subjected to the boiling 65% nitric acid (Huey Test) solution revealed that the Oxyarc process did not produce a sensitized zone. The reason this test fails to show a sensitized zone can be attributed to the speed of cutting which subjects the metal to such a short thermal cycle that it is not in the sensitizing zone long enough for appreciable precipitation of carbides.

A hardness survey of the cross section of the Type 304 plate revealed that the hardness was not increased. In fact, the first sixteenth inch was softer (70 Rockwell B) than normal plate hardness (75 Rockwell B). This indicated that the first one-sixteenth inch had received a more drastic quench-anneal than had the original plate.

Tests have also indicated that the mild steel rod does not contaminate the base metal adjacent to the cut, because the high temperature and the oxygen under pressure oxidize the rod and coating at the point of the arc before they can fuse into the parent metal.

Cutting Speeds and Costs

Although it is obviously impossible to give specific cost data to cover all applications of the process, some general cost factors have been worked out which will give some idea as to costs. It has been found on tests that 18 to 22% of the cutting cost with the Oxyarc process is labor cost; 65 to 72% is the cost of the rods; and the remainder is the cost of oxygen and electricity. In cutting alloy steels, the speed of cutting in general decreases as the alloy content increases, which, of course, increases the cost on alloy steels and nonferrous materials. In cutting ordinary carbon steel, the total cost is about the same as that of cutting with the oxyacetylene process. Below are listed some cutting speed data as well as overall cutting costs on various types of materials.

Material	Thick, In.	Speed, In. Per. Min.	Cost per Ft. of Cut (Inc. Rods, Oxygen, Current & Man Hr. $1.50 per Hr.)
Aluminum	3/8	15	$0.12
Monel	1	2.7	0.68
Hastelloy B	3/8	9	0.25
Bronze	1	3.3	0.43
Copper	1/4	23	0.13
Jessop E9	3/4	9.4	0.18
Stainless Clad	5/8	22.5	0.12
Cast Iron	2	2	0.71
Nickel	1/2	5.5	0.24
Stainless, Type 347	1/4	10	0.15

Since actual cutting starts without any preheat, overall cutting time is saved. This saving is especially important on jobs where many relatively short cuts are made.

The process is applicable to stack cutting and can be used to advantage in this way on thin section plate. In stack cutting it is not necessary to have the plates clamped since a satisfactory cut can be made even though the plates are separated as much as 1/8 in.

The surface roughness of the cut edge when using the Oxyarc process is largely dependent upon the type of material being cut. The smoothest cut is obtained on ordinary carbon steel, and this closely approaches the finish obtained by manual cutting with the oxyacetylene process. On the ferrous and nonferrous metal alloys, rougher cut edges result. When dealing with cast iron, a decidedly smoother cut can be achieved than with oxyacetylene cutting.

Applications

The Oxyarc process has applications ranging from uses in the small job shop to the large metal fabricating plants. In the fabrication of complicated shapes where holes for flange connections, manholes, and the like, must be cut in the part after forming, great savings in time and money can be realized. For example, in the construction of a 5-ft. dia. stainless tower four holes—two 4-in. in dia. and two 2½-in. in dia.—were cut in the side of the structure in about 15 min. This job would have required 24 man-hours by the usual method of drilling and chipping with a hand chisel.

Shown here is an example of the cut edge finish obtained on plain carbon steel.

Layout of sheet and plate for fabrication is a time consuming operation. With a rapid means of making cut-outs after the part is formed, the complicated layout before forming can be eliminated in many cases.

The ability of the process to rapidly pierce metals can be used to advantage in conjunction with oxyacetylene machine cutting of carbon steel where the cut does not start at an edge; a hole is first pierced with the Oxyarc process to give the oxyacetylene torch a starting point.

The process with its thin rod provides a means of cutting in places which are inaccessible to a regular burning torch; for example, cutting off internally mounted projections, or studs and bolts. It also has a special advantage in cutting pipe in that after cutting through one side of the pipe the rod can be pushed through and the remaining circumference cut from the inside.

The above are only a few representative applications of the Oxyarc process. Like other recently developed methods for cutting oxidation resistant materials, it is still relatively new and its capabilities and possible applications are at present being further explored. Experience so far has shown that the process is a versatile tool which will be useful to the metal fabricator in both the small and large shop.

Next month another recently developed method for cutting ferrous and nonferrous alloys—the powder cutting process—will be described—The Editors.

AN OUTSTANDING
1946
DEVELOPMENT IN

FINISHING

A New Process for Bright Copper Plating

by **HAROLD LEEVER,** *Mac Dermid Incorporated*

THROUGH THE DEVELOPMENT of a new bright copper plating process, it is now possible economically to copper, nickel and chromium plate zinc die castings and other soft metal parts without any intermediate buffing operations. Bright copper plating is easily performed with simple equipment and through the use of materials that are readily available in commercial quantities. Equally important, quality results are obtained with controls that are no more fussy than are required to do ordinary copper plating.

With the advent of bright copper plating as perfected by Mac Dermid, Inc., Waterbury, Conn., the lag in progress between electrodeposition of copper and the similar application of other metals has now been overcome. Possibly the reason for this lag lay in the fact that such a large quantity of copper plating has been used as undercoating rather than as a final plated surface.

Now for the first time it is possible to obtain mirror bright copper deposits directly from a simple cyanide copper plating solution over a wide range of operating conditions.

Zinc base die castings are electroplated by this process with much more success and freedom from trouble than by any other process. Due to the excellent covering power of this bath and the denseness of the copper deposit, much less trouble is experienced with black streaks appearing in the subsequent nickel deposit when plating die castings. Steel parts copper plated with bright copper can easily be buffed and the copper flowed into scratches, polishing marks and other defects due to the smoothness and softness of the copper deposit.

A standard solution formula would be as follows:

copper cyanide ..... 6 oz. per gal.
potassium cyanide .. 9 oz. per gal.

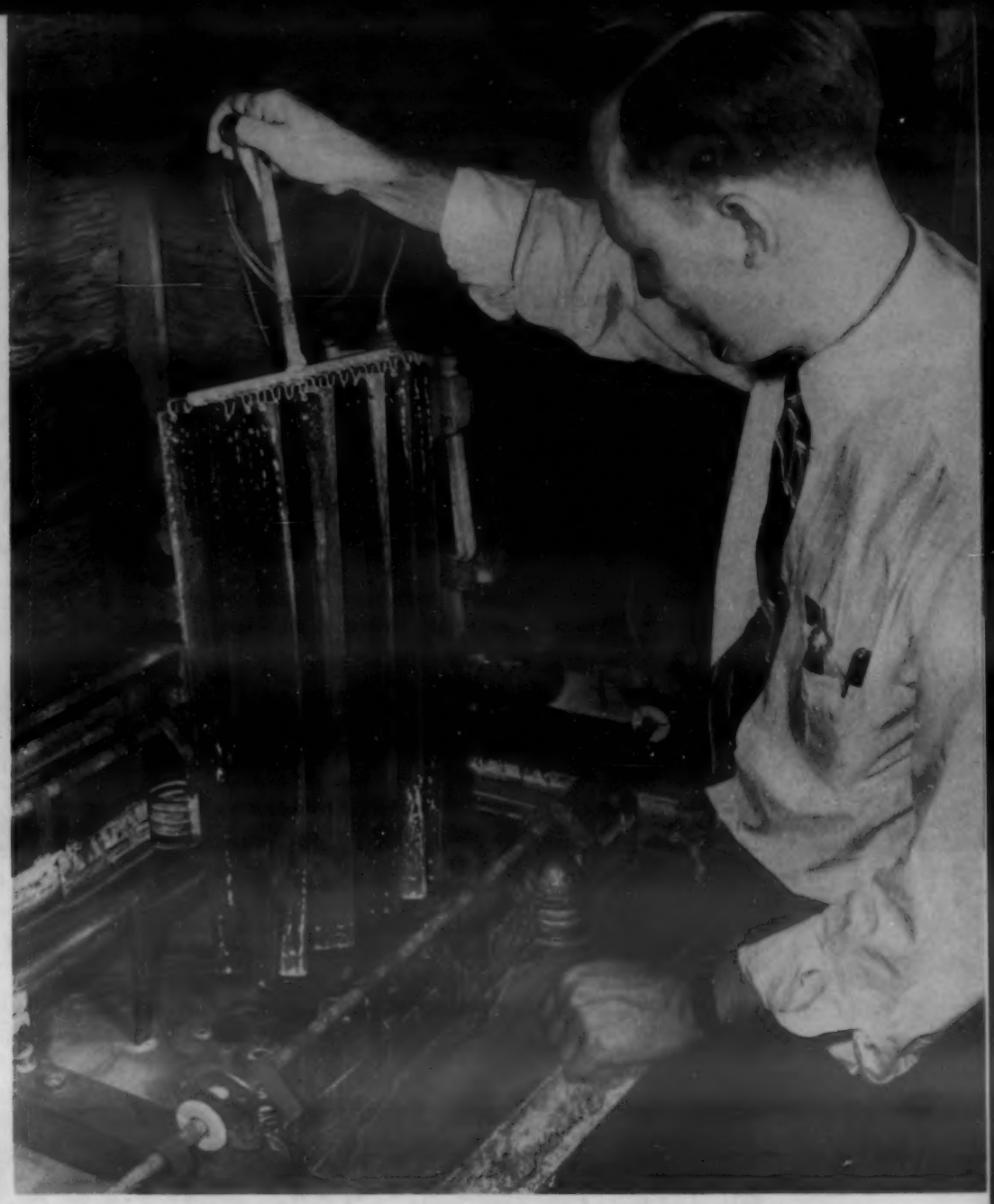
or

sodium cyanide .....7.5 oz. per gal.
caustic potash ..... 2 oz. per gal.

To this copper solution is added the proper amount of a proprietary product known as Mac Dermid Bright Copper Makeup.

Normal operating conditions are:

temperature .....140 to 160 F
pH .....130 to 13.5
current density .....15 to 25 amp. per sq. ft. at 1 to 1.5 v.
efficiency 100%



Bright copper plating can eliminate much of the polishing formerly required between plating operations. (Photo: Courtesy Westinghouse.)

Using the above set of conditions with the brightener, brilliant copper deposits are obtained directly from the solutions. Such deposits are particularly adapted as an undercoating for other metals such as nickel and chromium which normally are plated over copper.

Operation of the solution and control is extremely simple. A modified cyanide-type copper solution, to which two additional agents are joined, is used. Conventional methods of analysis are used for all standard ingredients. Limits on all ingredients are wide and consumption of chemicals low. The operation is performed at low temperature, and temperatures can vary considerably without affecting the operation.

It is generally possible to convert most cyanide type plating solutions by a simple treatment and produce results that are equal to those obtained from a new solution. While potassium salts are preferred as a base, it is possible to use sodium salts with only a slight decrease in efficiency, and mixtures produce proportional results.

Since the plating operates at 100% efficiency and copper is plated from the monovalent state, rather high plating speeds are achieved at very moderate current densities. For example, at 20 amp. per sq. ft., which is a commonly used current density, 0.001-in. of copper plate requires only ½-hr. plating time. This corresponds closely to bright plating of other metals. Special solutions and methods can be used to permit even higher speeds when and if necessary.

One feature of the solution which is noteworthy is its ability to plate smooth deposits even in comparatively dirty solutions. Since rough deposits cause hard buffing, lower the corrosion resistance and detract from the appearance, this single feature is especially important.

Operational costs are extremely low. The low temperature and high efficiency make the cyanide breakdown very low and usually more than offset cost of the addition agents. The pH of the solution is maintained by the addition of caustic potash, which is relatively inexpensive. The copper metal content is maintained by corrosion from the anodes. The anode corrosion is ordinarily 100%, so that only dragout losses need be made up by additions of copper cyanide. The addition agents are extremely stable and a few quarts per thousand gallons per day are sufficient for maintenance.

Since current densities are within common operating ranges, no change in regular low voltage current sources is required. Common operating voltage is only about 1.5 v., so that power cost is extremely low.

No restrictions are placed on the type of anode used. Rolled and cast slab anodes, ball anodes or electrolytic slabs are equally satisfactory. In order to insure high anode efficiency, it is necessary to keep the anode area as large as possible—preferably twice the maximum cathode area.

Likewise, no special cycles for cleaning and rinsing are necessary other than the care normally exercised in cleaning metal parts prior to bright nickel plating. Poor cleaning, however, should be guarded against since it definitely affects the bright range and adhesion as the copper is plated at 100% efficiency.

Normally no strike solution prior to the Mac Dermid bright copper is necessary; however, on deeply recessed parts it is advisable. When found necessary, the bright copper solution itself can be used for the strike using a 6-v. potential either in the same tank or a separate strike tank. An unusual feature of the bright copper is that even though an extremely high current density can be used for periods of as long as 5 min., the brilliance of the deposit can be restored by dropping to the bright current density range and continuing the plating.

After copper plating no special treatment is required prior to another plating operation. A careful cold water rinse is generally sufficient. Here again deeply recessed parts and those with blind holes provide the exception. On such parts a cold water rinse followed by a 5% sulfuric dip and another cold water rinse is good practice.

Equipment requirements are extremely simple. Ordinary steel tanks with steel coils are satisfactory with cathode rod agitation or solution agitation. Continuous filtration is not necessary and periodic filtration is only necessary in accordance with the usual practice employed in bright nickel plating. No loss of brighteners occurs, however, even if continuous filtration through carbon is used.

Rheostats of standard design are used or standard regulation of generators or rectifiers is satisfactory. The normal tank voltage is 1 to 2 v., which usually means a 4 to 5-v. drop rheostat should be used.

Developers of the Mac Dermid process claim that their plating method offers the following advantages over existing copper plating methods.

(1) Mirror bright deposits obtained directly from the bath.

(2) Low brightener consumption.

(3) Simple steel equipment used throughout.

(4) Any conventional type copper anodes can be used.

(5) Operation performed at low temperature and with low metal concentrations.

(6) Most standard cyanide copper baths can be converted by adjusting formula and adding brighteners.

(7) Water rinse only operation required after plating and prior to other plating processes, such as bright nickel or chromium.

(8) Operates at 100% efficiency; plates monovalent copper.

(9) Main copper bath can be used as a strike although no strike is normally required.

(10) Dull burnt deposits can be brightened by reducing current to normal bright current density range.

(11) Excellent adhesion and throwing power with wide bright plating range.

(12) Ease of buffing when desired or required.

No special equipment is required to do bright copper plating and most cyanide solutions can be converted for its use.

MATERIALS & METHODS MANUAL 22

This is another in a series of Manuals on engineering materials and processing methods, published at periodic intervals as special sections in Materials & Methods. Each of them is intended to be a compressed handbook on its particular subject and to be packed with useful reference data on the characteristics of certain materials or metal forms or with essential principles, best procedures and operating data for performing specific metalworking processes.

Annual Engineering Review

by the Staff of MATERIALS & METHODS

Presented here in concise, easy-to-read form is a summary of what has happened during the last year in the many fields which are concerned with the selection of engineering materials and methods of processing them. New materials and developments for processing, as well as advances in the older materials and methods, come about too fast for the ordinary individual to keep abreast. This review of 1946 is intended to serve as a memory refresher for those who are highly informed and as a quick means of bringing others up to date.

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Processing Methods . . . . . Page 98

Materials & Methods, January 1947
(Published since 1929 as Metals and Alloys)

Combinations of materials are finding increased use. Being made here is Metalite which consists of aluminum facing plates and a balsa wood core. (Photo: Courtesy United Aircraft Corp.)

Materials

The outstanding characteristic of 1946 with respect to materials was the difficulty in obtaining as much of them as engineers and manufacturers desired. For this there were several causes: strikes (in the *steel, aluminum, copper* and electrical industries early in the year and in the coal industry later); government fixed-price policies prior to O.P.A.'s demise, which kept badly needed foreign *copper* and *lead* away from our shores; wage-ceilings and general labor troubles in the foundry industry, which affected *gray iron castings* especially; and an overwhelming demand for materials for consumer products, which swamped all materials, but particularly *plastics.*

1947 will not be significantly better with respect to supply for several months. Copper and lead are already easier, but many steel products, most plastics, ferrous castings, rubber and tin will continue on the scarce list for most of this year. (And until *paper* eases, this journal and many other industrial magazines you read will continue to be slightly undersized, as we have been since last September.)

Technically, the most notable developments of the past year were more those of new applications—especially the applications of war-developed or war-improved materials to peacetime products — than the introduction of new materials to the market. And many of these new applications may not be too significant, either, since a considerable proportion of them were of a temporary or "substitute" nature, forced by existing shortages in several materials.

During the next year manufacturers are going to apply with increasing intensity two important materials-and-process-engineering lessons of the past twelve months: (1) Production costs can be vitally affected by the material selected to make a product—a slight modification in the nature, form or structure of a given raw material may have a great effect on the cost of processing the material into a finished product; and (2) processing techniques and production practices can do remarkable things in increasing the tensile strength, fatigue properties, corrosion resistance, wear resistance and general durability of an engineering material. Whether a material is annealed or normalized, shot-peened, welded, stress-relieved, as well as *how* it is heat treated, can often virtually make a different material out of all but a few substances.

The greatest new-material activity of 1946 was in the plastics field, where the rate of discovery and commercial introduction of new materials with better engineering properties is still bewilderingly high, and poses an increasingly complex nomenclature problem. This is especially true for the new users and potential users of plastics, many of whom have been accustomed only to the old familiar names of well-established metals and alloys and find the terminology of the plastics materials more Greek than Greek itself.

Among the metals, aluminum and magnesium alloys are currently exploiting new fields most rapidly. New strong copper alloys are certain to help the brasses and bronzes retain their traditional place in engineering as quality corrosion-resistant alloys. The fast-developing battle between copper and aluminum for conductor applications—from high-tension lines to small electric motors—will be settled on economic or technical grounds separately for each individual application; the trend, however, is toward aluminum, owing largely to the pronounced upward turn of copper prices.

And through it all, iron and steel of one sort or another continue to dwarf all other materials as to general engineering serviceability and production tonnage. Inroads on steel's applications are, of course, being made here and there, but new alloy and stainless steels have an interesting habit of recapturing many such markets, while coated steels appeal increasingly to engineers and designers seeking a combination of low-cost base material and durable surface properties.

Carbon and Low-Alloy Engineering Steels

In 1946, the first postwar year, carbon and low alloy engineering steels were supplied on a higher level of quality, uniformity and surface condition than before—and in some instances, during—the war. The most important trends among these most important of all engineering materials were (1) the movement toward specifying the heat treating grades on a hardenability rather than a strict chemical analysis basis, and (2) the increasing effect residual alloy content is having on the characteristics and selection of both plain carbon and alloy materials.

General industrial conditions have resulted in an unnaturally high proportion of alloy grades being chosen for jobs that plain carbon steels have always filled satisfactorily. In the first place, many users found it so difficult to obtain delivery on the plain carbon grades they wished to use that they finally accepted the closest thing to it, which often would be a manganese or other low-alloy steel that happened to be available at the moment. In the second place, this practice, and the use of alloy steel generally, seemed to be not so great a financial hardship as in normal times, because of the increasingly high proportion of operating cost taken up by labor alone and the decreasing fraction of total costs represented by raw materials. But in 1947 it is expected that labor costs will have reached such a level as to force manufacturers to scrutinize sharply their materials (and everything else) to cut costs in every possible place.

A very real problem to users of plain carbon and low-alloy steels at the moment is the high "residual" content of many of today's steels. The situation is caused by the extensive wartime manufacture and use of tri-alloy steels and the eventual return of much of this material to the mills as scrap; like a bad penny their nickel, chromium and molybdenum now turn up everywhere. The result has been mild steels that are not quite so "mild" as the user would like in his presses and under his welding torch. At the same time it has meant a "plain carbon steel" product with vastly improved corrosion resistance, since it is these first small amounts of alloy (especially the first 0.05% of copper, according to Frank LaQue) that are most effective in increasing the rust resistance of carbon steel. The plain truth is that it is now extremely difficult to produce or to obtain a real plain carbon steel, and alert materials engineers keep this fact prominently in mind when selecting and processing their raw materials.

The NE steels, those very-low-alloy tri-alloy steels developed during the war to save critical nickel, chromium, molybdenum and vanadium, are among the culprits that indirectly produced the present high-residual situation. They are still being specified and made in large quantities, especially the 8600 series. 8630 tubing is popular for its strength, ease of forming and weldability; 8650 is increasingly used for heavy duty springs. At the same time the pre-war SAE steels—for example, 4615 for carburized parts, once the largest tonnage alloy steel—are making a strong comeback, primarily because of their generally better heat treating characteristics.

The "H" steels, introduced in 1945, are still the subject of much study and speculation, but the tendency is steadily toward increased use of "H" steel specifications. These specifications (soon to be somewhat revised) involve specification and selection of steels (basically the current SAE and NE grades) according to hardenability bands, with broader composition ranges specified—rather than according to narrow chemical analysis limits, the traditional practice.

The low-alloy, high-strength steels (mostly as-rolled but sometimes heat treated) are being widely studied and increasingly applied for many mobile products requiring a combination of lighter weight, adequate design strength (these steels have yield strengths greater than 50,000 and tensiles over 70,000 psi.) and increased corrosion resistance over plain carbon steels. They are inexpensive competitors of the aluminum alloys and strong stainless steels, on a strength/weight basis for railway cars, trucks, buses, earth-moving equipment, etc.

The railroad industry, while boasting of occasional aluminum box-cars, seems to be selecting the rolled low alloy high strength steels for most of its new lightweight freight cars. A typical example is a new all-welded Cor-Ten hopper car of simple construction and tight seals, which weighs only 33,500 lb.—6,540 lb. lighter than the A.A.R. standard carbon steel car. These steels are also being used on passenger automobiles—one application being their use for bumpers.

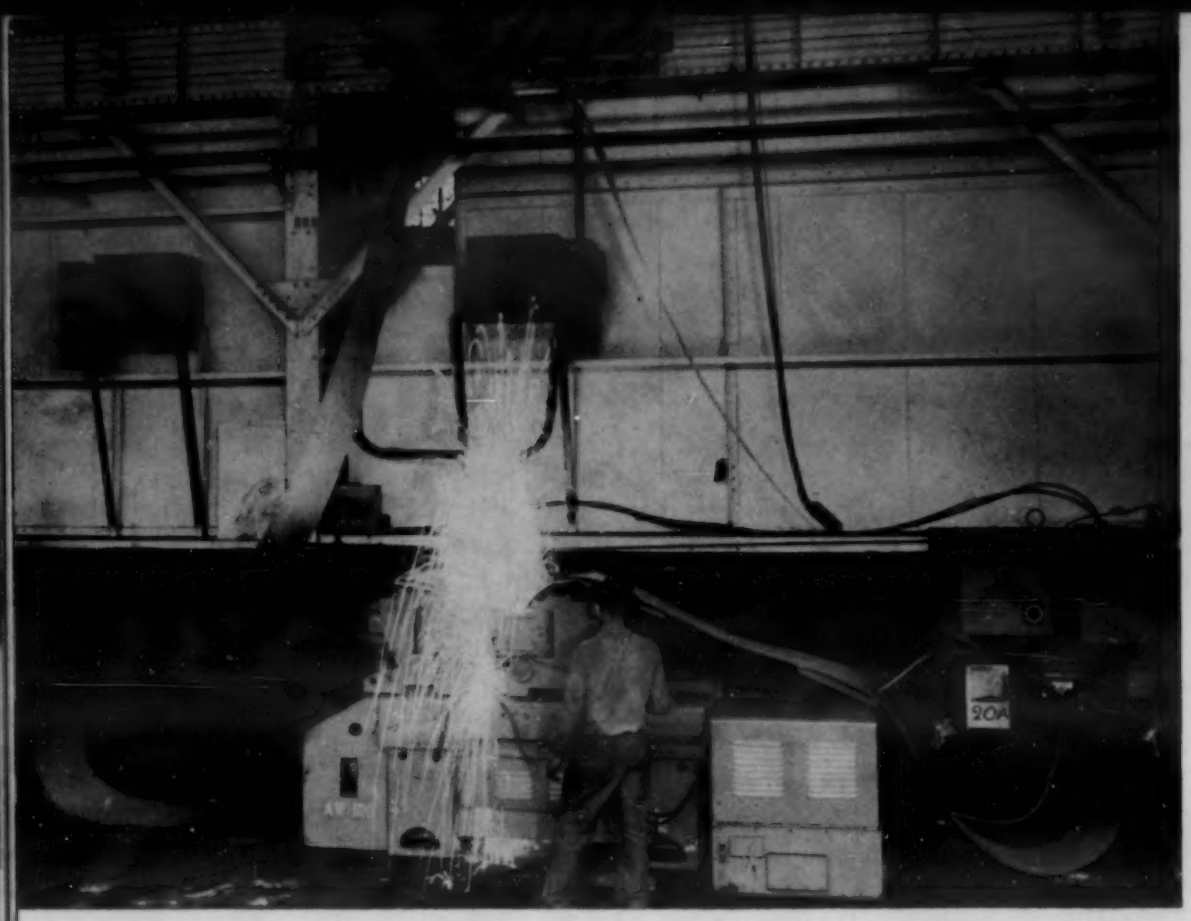
Despite experimental cars with plastic bodies and at least one small automobile with an aluminum body, deep drawn mild steel continues the overwhelming choice for auto bodies. For mass-produced cars, it looks as though deep-drawn steel will remain immune to serious challenge for years, because of its low cost and amenability to high-production operations.

Steel wire as a raw material offers much more to the engineer than in years past. Great quantities of fine wire are now produced to tolerances of ± 0.0002 in., some of it with tensile strengths upwards of 300,000 psi. An important current application is the use of 0.0059-in. dia. wire in heavy duty tires, to provide a core for the bead holding the tires on their rims. A wartime development evidently here to stay is the availability of a high-grade American valve spring material, which before the war could be obtained only from Swedish manufacturers.

Perhaps typical of progress in putting steel to work today is the completely redesigned Westinghouse electric motor that recently received much publicity. From the materials point of view, the outstanding feature was the replacement of cast iron with steel wherever possible, giving a motor 35% smaller and having 134% more starting torque per lb. of motor than conventional motors of similar rating.

Stainless Steels, Tool Steels, Heat Resistant Alloys, etc.

Stainless steels are not so hard-to-get, relatively speaking, as some of their ferrous brethren. The mills are all busy, however, and the industry's output for 1946 may well set a record. The producing industry underwent many changes, among them American Rolling Mill Co.'s complete purchase of Rustless, Eastern Stainless Steel Co.'s substantial expansion, the formation of Washington Steel Co. in Washington, Pa., etc.



Ends of stainless steel strip are welded to form a 66-ft. polishing belt for finishing white wall tire rims. (Photo: Courtesy American Welding & Mfg. Co.)

The most popular steels of the group continue to be the 18 and 8 nickel-chromium types 302 and 304, with type 316 (a molybdenum-bearing grade) coming in for increased attention for special corrosive and high-temperature conditions.

The outstanding new steel developments in the stainless field were the age-hardening grades introduced in 1946. These steels have the great advantage of developing high strengths (comparable to those obtained from cold-rolled stainless) but by heat treatment after forming; the steels are purchased in the annealed condition, formed while soft and easily workable, and then precipitation-hardened to tensiles of 195,000 to 225,000 psi., yield strengths of 180,000 to 210,000 psi., and hardnesses of 39 to 47 Rockwell C. This may overcome one of the disadvantages that stainless heretofore has carried in competition with aluminum alloys for lightweight construction—the necessity to buy the material in the difficult-to-work cold rolled state in order to achieve high-strength characteristics in the finished product.

Formal announcement and considerable technical data on one of these age-hardening stainless steels (Carnegie-Illinois Steel Corp.'s Stainless "W") appeared early in 1946 (see MATERIALS & METHODS for February, 1946, page 432). The steel is a 17-7 grade with 0.07% carbon; titanium (0.07%) and aluminum (0.20%) are the elements chiefly responsible for the precipitation-hardenability of this material. Other age-hardening stainless steels have been developed but not yet publicized, for example Armco-Rustless' "PH" alloys.

Also, two or three stainless steel producers are now working on virtually carbon-free materials that are therefore free of carbide precipitation and consequent intergranular corrosion. Such steels require no stabilizing ingredients and need not be "babied" in processing to avoid slow cooling through the temperature range in which carbide precipitation usually occurs. If such steels are completely and successfully developed, they should be a real boon to the fabrication of stainless steel by welding.

The work done in 1946 by Armco, Washington Steel Co. and others, using the Sendzimir rolling mill process, forecasts the ultimate availability of lower-cost high-strength stainless sheet and strip in very thin gages.

Stainless-clad steels are receiving increased attention, and this combination of inexpensive base metal with high-quality surface material will have especially great appeal to cost-conscious engineers in 1947. One interesting 1946 application for stainless clad was for automobile bumpers, bumper guards and gravel guards, which take a high polish, won't chip, flake or peel, and are relatively inexpensive. The producers, however, do not all regard this as an application that takes the fullest advantage of stainless-clad's properties, and feel that its potentialities are far greater than this.

Heat resistant alloys, and especially the "superalloys" developed for wartime use in turbosuperchargers, gas turbines, jet engines, etc., received widespread publicity in 1946. Reports showed Timken 16-25-6 alloy to be outstanding for forged wheels and other components. Allegheny Ludlum's S-816 alloy (44 cobalt, 20 chromium, 20 nickel, 4 molybdenum, 4 tungsten, 4% columbium, described in our October 1946 issue), was shown to have exceptional properties, and some high-temperature fatigue tests reveal S-816 to be the best superalloy yet developed in this respect.

An interesting wartime development that came to light publicly in 1946 was the use of a new type of austenitic steel wire cord with thermal expansion characteristics similar to those of aluminum alloy. This stainless wire, which was used to help stabilize flight control, contains 12 nickel, 5 manganese, 4 chromium and 0.5 to 0.6% carbon. It remains austenitic down to −100 F, can be drawn to fine wire, and in its chief application is encased in 17ST aluminum alloy tubing.

For general uses, however, the high-manganese austenitic steels, so useful in wartime to save nickel, are now regarded unfavorably except as emergency substitutes, because of their higher rolling cost and somewhat inferior corrosion resistance.

A new corrosion-resistant tubing steel with excellent toughness at low temperatures was announced during the year. The property of Babcock & Wilcox Tube Co., it is called B&W Nicloy 9 and contains 9% nickel. It rates as one of the outstanding ferrous-materials developments of 1946 and is described completely in one of the feature articles in this issue.

The first postwar year brought considerable change in the tool steel picture and a general reversion to prewar types of steel. However, the molybdenum grades of high-speed steel, especially the type M-1 (the "Mo-Max" type containing about 8.5 molybdenum, 1.5 tungsten, 3.75 chromium and 1 vanadium) and type M-2 (6.5 tungsten, 5 molybdenum, 4 chromium, 2 vanadium), have more than proved their real merit and are holding their own.

Among the new tool steels, two are particularly worthy of mention. Vanadium-Alloys Steel Co. introduced Vasco Supreme, a high-carbon, high-speed

steel with 5% vanadium, described as closing the gap between 18-4-1 and the cast nonferrous tool materials. The high carbon content results in great hardness (67 to 68 Rockwell C) on heat treatment; brittleness is avoided because of the vanadium content. Users report speeds 15 to 100% higher, and considerable improvement in life between grinds, especially on "difficult-to-machine" materials.

Carpenter Steel Co. brought out a new air-hardening die steel (called "Vega") amenable to a simple, low-temperature hardening treatment with minimum distortion. The new steel combines the deep-hardening quality of air-hardening steel with the low-temperature treatments characteristic of oil-hardening steels. The steel can be hardened to 60 Rockwell C in 8-in. dia. bars, and to higher hardnesses in smaller sections.

Special processing at one alloy steel mill (Latrobe Electric Steel Co.) is responsible for the availability of high-speed steel bars virtually free of carbide segregation at the center. Called "desegatized" steels, such materials are said to be more uniform as to structure and properties, with better cutting and wear properties, than high-speed steel not so treated. Another brand of high-speed steel treated to eliminate carbide segregation is Jessop Steel Co.'s "Vee-Oginized" steel, developed in collaboration with Barium Steel & Forge Co., Inc.

A number of new special ferrous alloys, mostly for electrical applications, were announced in recent months. General Electric brought out Cunico, Cunife, Vectolite, Alnico 12 and Silmanal, all magnet materials with special properties. Cunife, for example, is a copper-nickel-iron alloy which is available as wire stock and can be flattened, formed, drawn, punched and machined. Vectolite is a nonmetallic, nonconducting light-weight magnet material consisting of sintered oxides of iron and cobalt.

Cast Irons and Steels

Cast ferrous metals continue to perform in peace the same type of engineering duties they carried out so successfully during the war. Plagued as they have been by absenteeism and other labor problems, price troubles and periodic shortages of pig iron and coke, foundries have managed to produce a respectable output of castings and to keep on improving the metallurgical nature and engineering characteristics of their products.

The trend toward making gray iron a continually better engineering material continues. The Navy Dept. is now carrying out an extensive research program designed to do in the gray iron field what Naval Research has done in the steel castings field. The Gray Iron Founders' Society has laid out its program for technical research to include studies on improving the fatigue properties of gray iron, on the corrosion fatigue of welded joints, on the surface characteristics of gray iron, on its physical properties as related to sulfur content, etc.

Heat resistant cast irons are edging over toward the center of the stage, there being increasing demands for these relatively inexpensive materials for certain parts of power plant equipment, including marine gas turbines. Alloy irons (*e.g.* HB-HC Meehanite, containing 1.35 copper and 0.7% chromium) do surprisingly well in high temperature stress-rupture tests. One of the special features of cast iron's performance at high temperatures is that this material — normally considered brittle or at best "elastic" in its behavior—will flow plastically and generally behave in ductile fashion at elevated temperatures.

Alloy irons are now accepted engineering materials for heavy duty uses. High strength gray irons with 1.5 to 5% nickel are used for diesel crankshafts, cylinder liners and aircraft piston rings. Many large crankshaft applications, especially for marine diesel equipment, have been recently made, the parts successfully replacing steel forgings in many cases. Centrifugally cast iron brake drums, made by casting alloy iron around a flanged and corrugated steel shell, have been found superior from the standpoint of minimum wear, heat-checking and cracking of the drum.

The outstanding recent developments among malleable iron have been (1) the great increase in size of malleable castings that can now be made, some weighing 300 to 400 lb., with 4-in. section thicknesses, and (2) the use of thousandths of a per cent of boron in the composition to overcome the effect of chromium in slowing up the malleableizing cycle.

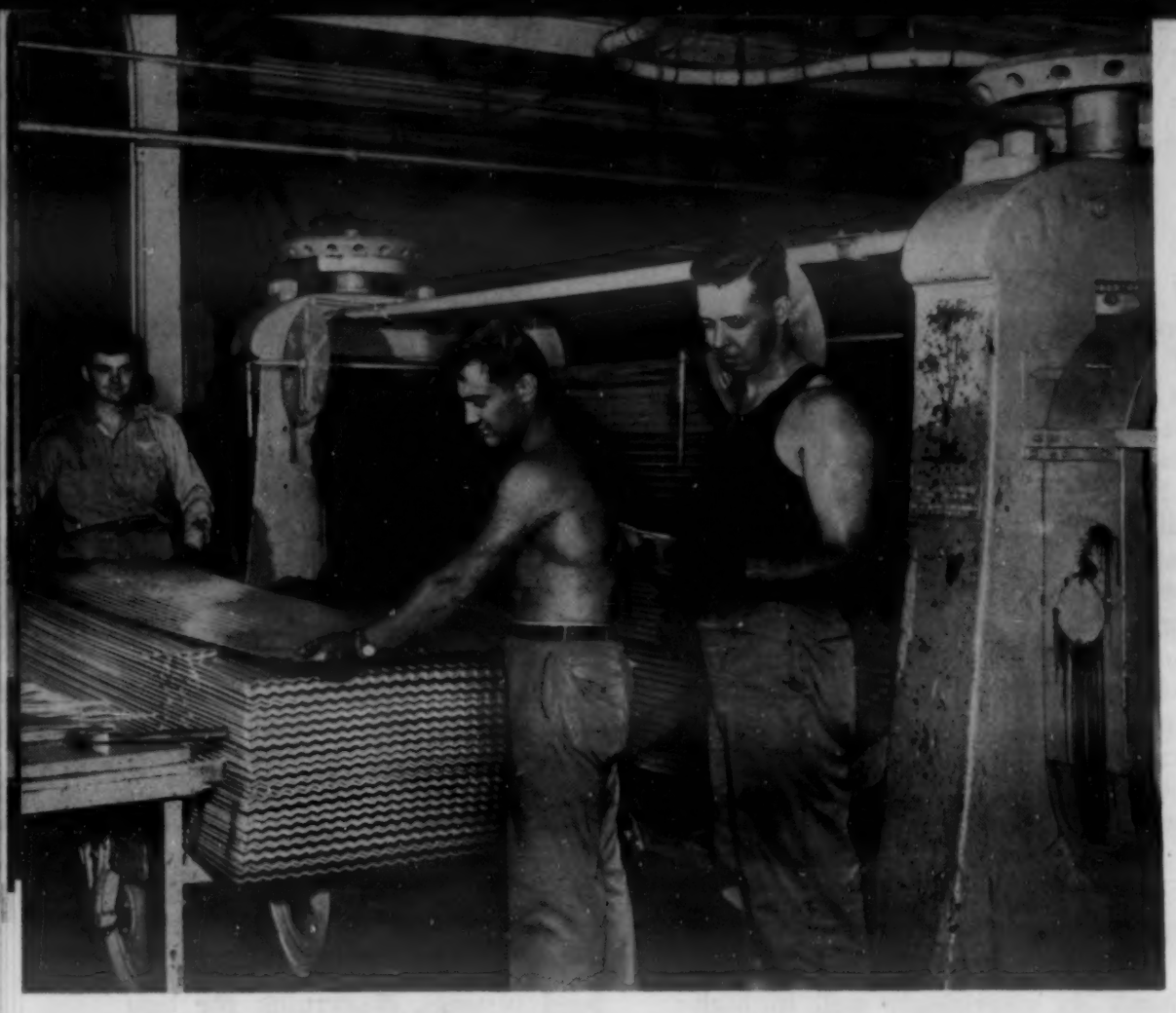
Steel castings, concerning the heat treatment of which so much has been learned in recent years, are increasingly used for heavy structural purposes. Liquid quench-and-temper treatments are increasingly specified as property-developing requirements. During the last year or so there has been growing interest in alloy cast steels, which when properly heat treated have high strength and can even be utilized in weight-saving design.

Much information on "the graphitization problem" that arose with cast steel piping used at elevated temperatures during the war was released this year. Failures due to this cause, which first appeared on an important scale in carbon and carbon-molybdenum cast steels in 1943, were studied by a large number of investigators, who reported their findings in an A.S.M.E. symposium. The consensus seemed to be that neither melting and deoxidation practice nor heat treatment could insure against graphitization, but that alloy additions that stabilized the carbides were highly useful.

In one case, for example, it was found that cast steels containing more than 0.5% chromium did not graphitize. More generally it was stated that high chromium and nickel-chromium-molybdenum steels were practical proof against graphitization.

Aluminum and Magnesium Alloys

Those who call this the "light metal age" can point to many developments to bear out their slogan. Certainly from the percentage of all new alloys that class as light metals, aluminum and magnesium would appear to be among the most progressive of modern metals. What with Alcoa's 75S, 63S and Alclad 3S, Reynolds' R303 and R317, Dow's



Part of the terrific demand for building materials is being met by using corrugated aluminum roofing and siding. (Photo: Courtesy Reynolds Metals Co.)

ZK60 alloy, Acme's Almag 55, Eclipse-Pioneer's Eclipsaloy 130, and others there seems no end of interesting new lightweight alloys.

The high-strength materials 75S, R303 and the free-cutting R317, described in these columns a year ago, are gradually finding structural uses outside the aircraft field. A new nonstructural application for 75S is for durable, non-tarnishing keys, which are light in weight, do not wear out one's pockets and can be finished in various attractive colors. Alclad 3S, used during the war for aviation gasoline tanks and for water and gasoline tanks on PT boats, is now being employed successfully for such products as mason-jar caps and tea kettles.

Another recent development is Alcoa's 63S extrusion alloy—corrosion resistant and amenable to clear, bright anodic treatment with a minimum of streaking and discoloration, "63S" is expected to find wide use in architecture, escalators, furniture, etc. New casting alloys like Harrington's aluminum-copper-beryllium materials and Acme's Almag 55 (described as having the greatest strength plus impact resistance of any cast aluminum alloy yet produced—see the feature article on this new development elsewhere in this issue) are being studied with close interest.

Though Reynolds' R-317 alloy was mentioned here a year ago, some interesting experience with this free-machining alloy in "T" form has been accumulated since then. The material is strong, but can be employed in speeds up to double normal speeds used with free-cutting brass and three times the speed normally used with free-cutting steel screw stock.

A new aluminum forging alloy, developed during the war and not yet included in the standard alloy listings, contains 2 copper, 2 nickel and 0.7% manganese. It is used for aircraft pistons and is said to have a combination of lightness, strength, resistance to scoring and wear impossible of attainment in any other material.

Aluminum alloys are now being intensively investigated for a number of new applications. Many readers are already familiar with the aluminum bearings development, described in our September 1946 issue, a major feature of which is the use of a relatively new aluminum-tin alloy. Tests on an experimental ship model have shown the engineering practicality of using aluminum alloys for the superstructures of passenger and cargo ships.

The incorporation of a substantial amount of aluminum in one automobile design resulted in a 500-lb. reduction in overall weight. An "all aluminum" automobile engine is reported to be exceptionally good in performance. The Crosley car features an aluminum body, while the Tucker "Torpedo," another lightweight automobile, contains 1150 lb. of aluminum and is 1000 lb. lighter than other cars of comparable size.

The aluminum-faced wood-core sandwich materials, now available from 4 or 5 manufacturers, are attracting widespread and excited interest for aircraft, home building and furniture construction. The outer sheets are aluminum between which is a bonded panel of plywood, wood-fibre composition or other lightweight nonmetallic material. The combinations have far and away the highest strength/weight ratios of all available structural materials.

Although its tonnage production is smaller, magnesium's current rate of application-growth is even more spectacular than aluminum's. As with aluminum, the development of new alloys and industry's increasing familiarity with methods for processing and handling the material are responsible for this trend.

The alloying of magnesium with zirconium has progressed far in Britain under the aegis of Magnesium Elektron, Ltd. In the United States almost ready for commercial production is Dow's ZK60 alloy of zirconium, zinc and magnesium, which combines the highest mechanical properties yet achieved in magnesium, with much better ductility, toughness and higher extrusion speed than possessed by the previously best high-strength alloy, AZ80 (8.5 aluminum, 0.5% zinc). Another new magnesium alloy Z-1 (1.5 Zn) shows promise of becoming a less expensive material than present alloys yet suitable for many applications where high mechanical properties are not essential.

Magnesium is increasingly used for the cathodic protection of pipe lines, marine parts, etc. Properly installed in pipeline service, 500 ampere-hr. of electricity can be realized per lb. of magnesium consumed at the anode. This compares with 373 ampere-hr. for zinc, the most commonly used cathodic protection material.

Magnesium for certain types of storage batteries (see MATERIALS & METHODS for December 1946), for photoengravers plates, and for canoes are other fast-growing uses that should have much significance for application engineers in many product-fabricating industries.

Copper and Its Alloys

Copper, along with lead and tin, became one of the scarce metals in 1946, due largely to paralyzing strikes in virtually all departments of the industry—mining, refining and fabrication. On top of these came strikes in trucking, shipping, etc., all of which handicapped the use of copper. Therefore, there was more opportunity and incentive to bring out alloys in the other metals, say aluminum and magnesium, rather than in copper.

The beryllium copper alloys are still the intriguing possibility of a year ago, with more applications and with more metals found with which beryllium can profitably alloy. An important development of the year was the bringing out of beryllium copper coils, pre-tempered, and which require no further heat treatment after fabrication. Previously, cold-rolled beryllium copper had to be jigged, heat-treated for 2½ hr. at 600 F, pickled, washed and dried before processing further. According to Slagle Beryllium Co., its developers, ductility is better than would be expected. In using this new beryllium copper, when other alloys are replaced, no changes in dies are necessary.

The plentifulness of aluminum and the aggressiveness of that industry have been responsible for a few new aluminum bronzes. One of these, Molin metal, was brought out by American Art Alloys, Inc., Kokomo, Ind. It is described as a pure aluminum bronze, without iron or other additions, produced in various degrees of hardness. It is said to be suitable for castings or forgings, including aircraft forgings and valve seat inserts for aircraft engines.

A new cupro-nickel-aluminum bronze containing 12 nickel, 0.6 iron, 1.0 manganese and 1.5% aluminum combines superior resistance to salt water corrosion and excellent mechanical properties, including 85 to 95,000 psi. tensile strength. It is expected to find broad usage in marine hardware and ship propellers where high strength and sea water corrosion resistance are required.

A tough centrifugally cast aluminum bronze bushing stock, called "Torrance standard bronze," had its original workout in aircraft, automotive, ordnance and maritime industries and is now being promoted for peace. The maker, Torrance Brass Foundry, Torrance, Cal., claims that it offers high resistance to corrosion and abrasion, has exceptional physical properties, a low coefficient of friction and is 10 to 20% lighter than common bearing bronzes. This heavy duty bronze stock is available to manufacturers with limited stock bronze equipment, sizes 1½ to 6¼ in. O.D., with practical inside diameters. Centrifugal casting insures maximum density, uniform grain structure and total absence of inclusions.

The development of the electrolytic production of manganese by the U. S. Bureau of Mines has provided a pure manganese, promoting better alloys of which manganese is a component. Recent studies of copper, manganese, zinc alloys, with compositions in the alpha region, have indicated that considerable amounts of electrolytic manganese may be introduced, increasing the strength and hardness without excessive losses in ductility.

More recently alloys containing 50% copper with manganese increasing from 5 to 25% and zinc decreasing from 35 to 15% have been studied. After annealing, tensile strength varied from 67,000 psi. to 55,000 psi., the maximum being obtained with 5% manganese, which reached a tensile strength of 115,000 psi., a proof stress of 103,000 psi., and an elongation of 3%. The alloys are amenable to cold work hardening. The strength and hardness of the alloy decreased as the manganese content was increased. The single phase alpha solid solution was reached at 20% manganese.

Ampco Metal, Inc. brought out a few new alloys. Its "Ampcoloy 90" is in the form of copper castings with guaranteed electrical conductivity of 90% minimum, with values up to 98% sometimes obtained. It is useful for making electrode holders for arc furnaces, electrical contacts, and castings for resistance welding machines.

Ampcoloy 342, 382 and 742 are three continuous cast bronzes in rod form. They have an extremely uniform structure, with lead or other secondary constituents uniformly dispersed and in a finely divided state throughout. Dirt, dross and shrinkage cavities are excluded by the nature of the continuous casting process. They are for use in automatic screw machines.

Another series of three alloys, Viculoy 1, 2 and 3, were brought out by the Akron Bronze & Aluminum Co., Akron, Ohio. They have unusual strength and hardness. The No. 1 is for gears, pinions, flash and butt-welding dies, bronze-welding electrodes and heavy duty welding wheels. The No. 2 is for applications where hard-drawn pure copper is needed, such as current-carrying parts. No. 3 is for use where castings must withstand shock loads, abuse, pressure resistance, high speeds, etc., as in gears, die molds, small machine parts; also for non-sparking tools.

Other Nonferrous Metals

The economics situation played a prominent role in shaping things that have come as well as those still to come. During the war there was a great scramble to re-design alloys to use smaller percentages of tin. Economic influences still prevail. The tin supply has not improved; lead, so abundant during the early part of the war, has even recently been among the extremely scarce metals. Silver, partly because of politics, took a recent advance in price, so that silver brazing alloys had to be lessened in silver content to keep them economical and competitive.

Noted prominently during the past year, too, has been the tendency to bring out more electrical contact metals that stand up better under punishment; also to bring out high melting alloys, such as molybdenum and tungsten, in more versatile, popular and bulkier forms.

Handy & Harman introduced two silver brazing alloys late in the year: Easy-Flo 45 and Easy-Flo 35. The first is a 45% silver alloy, containing copper, zinc and cadmium, with a melting range of 1120 to 1145 F. Joints produced between ferrous, nonferrous and dissimilar metals are strong, ductile and leaktight. The 35% alloy has a wider melting range, 1115 to 1295 F and is free flowing at an exceptionally low temperature for such an alloy.

In the electrical contact metals field Callite Tungsten Corp. brought forth a silver-molybdenum alloy, "Callinite Type SM" which is good for switch

contact surfaces for heavy current. It is a high conductivity facing material where pitting, sticking or welding normally occurs. For the same general purpose of contact the Gibson Electric Co. brought forth silver tungsten and silver tungsten carbide.

Westinghouse can now make molybdenum into various shapes, with the cost reduced to one-third that previously prevailing. The company can mold into rounds, squares, with fins, or angles, or holes and with much larger over-all dimensions than heretofore. During the same year Kennametal, Inc. developed a new process for producing tungsten shapes for crucibles and boats for high temperature melting. They alloy with tantalum to improve strength.

Elsewhere we have mentioned the greater possibilities of introducing manganese into alloys since the electrolytic process was developed by the Bureau of Mines. Metallurgists now claim that this pure manganese has advantages over low carbon ferromanganese in the manufacture of stainless steel.

Zirconium has been mentioned in our light metals section. It has recently been used in the vacuum tube industry since it is a degassing agent in the casting of metal and alloying agent in producing anti-corrosion and in high speed tool steels.

It is expected that an alloy of beryllium and nickel will soon be marketed. Strip, heat-treated from the cold rolled condition, has a tensile of 270,000 psi., Brinell of 480, with 8.8% elongation. It was found recently that "pure" beryllium can be made somewhat ductile by small additions of titanium or zirconium. Hot-rolled into sheet and used as X-ray windows, it is 17 times as transparent to X-rays as is aluminum. Recently it has been found, too, that beryllium makes aluminum tarnish-resisting in cooking utensils. The addition alloy, or hardener, is supplied as 5% beryllium, with the balance divided between aluminum and magnesium. Talk of the remarkable strength weight properties of 75 beryllium, 25 aluminum alloys, if they were only more practical commercially, is again current.

A series of high density alloys, "Dense Alloys 112," have been sponsored by Callite Tungsten Corp. where high strength and high density are of prime importance. They are good as balancing weights where space is a prime factor. Thus lead has a density of 11.3 gms. per c.c.; these, 17.3 gms. The alloys are made by powder metallurgy. Type P is largely tungsten, with copper, nickel, etc. Type E, tungsten, with cobalt, silicon, etc. Type Y, tungsten, with cobalt and nickel.

A new nickel oxide sinter was brought out late in 1946 by International Nickel as a cheaper substitute for electrolytic nickel in steel manufacture. It will be produced at a new plant being built at Copper Cliff, Ont., scheduled to start operations in 1947.

A new application, involving nickel, is a 9% nickel steel tubing for sub zero temperatures, made by Babcock & Wilcox Tube Co., the first time this steel has been employed in tubular form.

Gas free metals for experimental work and which lend themselves to vacuum melting are being prepared by the National Research Corp., Boston.

Interesting are the several new permanent magnet alloys introduced by General Electric Co., described in an earlier section (on stainless steels, etc.). A new type of nonferrous magnetic material introduced by American Electro Metals Co. and called "Permet," contains 45 copper, 30 cobalt and 25 nickel.

A series of nonferrous phosphide brazing alloys that have resistance to sulphuric, hydrochloric and many other acids has been introduced by McCauley Alloy Sales Co. Called "Macoloy," one is fluid at 1150 F, another at 1180 F and a third at 1600 to 1900 F. The second is a copper, tin, antimony, phosphorous alloy.

Another new 1946 alloy is "Moldaloy" (a product of Trethaway Associates, Inc.), a low temperature melting alloy of bismuth, lead, tin and antimony. It is used for plastics, rubber, and wax molds, chuck jaws, nests for drill jigs, models for engraving machines, forming dies for metal or plastics sheets, etc. Its principal advantages over similar alloys are: Higher melting temperature (430 F) which allows a wide factor of safety where heat is generated; unusual stability (shrinkage after solidifying is only 0.001 in. per in.); and lower price. It can be cast or sprayed. In one application it is sprayed on wood patterns and core boxes as a protective coating.

As to three of the rare metals, zirconium, thorium and uranium, the principal changes of the year have been improvements in techniques and working conditions rather than in basic processes. Production can be accomplished faster and in larger quantity and in some cases more common and more universal uses are envisioned. These metals have now been made in form of sheets, rods and wire. They have been made more ductile, thorium having been made which can be machined, tapped and drilled. Zirconium for beautiful, non-tarnishing bathroom fixtures is being imagined. Thorium's qualities are very good and it has recently been described as a "respectable and lovely thing to work with." Uranium, which was being made to sell at $22 per lb. at war's end, is now considerably cheaper.

To end on a *really* novel note, we have uncovered a new use for the noble metal, palladium—a new adjustable wedding ring. (Good for today's rather loose marital arrangements, since it will also fit the second wife, just in case!)

Parts and Metal-Forms

The trend toward greater use of precision methods of making parts to final shape and size without machining continued in 1946 but at a slower rate. The war-impelled need to get things produced by whatever process (especially if it circumvented the use of critical machine tools) had vanished and manufacturers could be more selective on a cost and facilities basis than in the few previous years.

This has meant that many products that were made by powder metallurgy methods or precision casting in 1944 will be machined from bar stock or sand castings in 1947. At the same time the "old standby" precise parts or production methods (like die castings), which are so attractive economically to manufacturers of mass-produced civilian products, are finding new uses on an extensive scale, especially in the automotive and electrical equipment fields.

The powder metallurgy parts situation is one of the most interesting of all. During the war the process was

Electric motors have been made smaller and lighter per horsepower and manufacturing costs have been lowered by using steel instead of cast iron in frames and end bells. (Photo: Courtesy Westinghouse Electric Corp.)

widely used to make parts that could normally have been made by machining or perhaps die casting. In the early postwar months many of these applications fell by the wayside. During 1946 virtually all large-tonnage powder metallurgy applications have been for "specialty" products—those parts that for structural or other reasons can be made only from metal powders—and powder metallurgy is now described as having "settled down to its proper place." Actually this place is of tremendous and growing importance and the production of sintered bearings, friction materials, electrical contacts, cemented carbides, filters, etc. is steadily increasing. And interest in "competitive parts" production by powder metallurgy is now merely dormant, still awaiting the promised advent of low-cost, pressable iron powder.

A new "cemented steel" product (called Sinteel "G," made by American Electro Metal Co.) produced by infiltrating a pressed steel powder skeleton with molten copper was announced early in the year. This new material has strengths over 150,000 psi. after precipitation hardening, together with several interesting design possibilities.

One company specializing in alloy powder metallurgy (Micro Metallic Co.) uses fully alloyed stainless steel powder to make sintered ductile plates that can be formed slightly to produce stainless filters, aeration units, flame arresters, etc. And experience gained by a number of companies in the manufacture of sintered nickel filters for the VT fuse is now being applied to other products.

Increased usage is being found for brass parts, which are now sintered in dry controlled atmospheres that do not dezincify the material. Some remarkably small brass parts and thin parts with intricately marked surfaces (*e.g.* watch dials with embossed numerals) are now made from metal powders.

Die castings have recovered all the markets lost during the war and are pushing ahead on other fronts. Aluminum and magnesium die castings found wide application in the Jack & Heintz engines, especially designed to accommodate this process. Zinc alloy die castings seem, if anything, to appeal even more to designers of 1947 automobiles than they did in 1941, several newly designed parts being chosen as die castings rather than as plated steel stampings. The possible introduction in 1947 of a new high-strength zinc die casting alloy now being whispered about may bring additional civilian products under the zinc-die-casting wing. Very large zinc die castings (up to 19 lb.) as well as other types (*e.g.* 14-lb. aluminum castings) are now available from die casters using machines now on the market.

The precision investment casting manufacturers passed through a period of adjustment, quite violent in some cases, to postwar conditions. Some companies dropped out of the business, while others undertook considerable expansion. From the parts-user's point of view, precision castings are now available on a higher technical level than ever before, and in commercial quantities in virtually all materials—alloy steels, cobalt alloys, copper alloys, aluminum, precious metals, etc. The growing use of the process for molds, patterns, experimental parts and model work, and for making such products as finned cylinders were 1946 accomplishments that mark precision castings as a metal-form that has firmly established itself in industry.

Centrifugal castings found new friends in 1946. Centrifugally cast steel tubing, especially for rolls and cylinders in high alloy materials that are difficult to pierce and roll, made especially good progress. Some interesting products have been fabricated by welding centrifugally cast tubular sections to statically cast or forged flanges and headers. In the automotive field many more parts such as sleeves—both ferrous and nonferrous—were made of centrifugal castings in 1946 than prewar.

An interesting switch has occurred in applications for light metal extrusions, for which the largest demands are now non-military and non-aircraft in nature. Large quantities are still used in aircraft (*e.g.* for seating equipment) but textile equipment, truck bodies, storm windows, screen frames, materials-handling equipment, metal furniture, etc. require even greater tonnages—more indeed than is available at the moment. Stepped and tapered extrusions have turned out to be a great success, at least in the specialized applications for which they were developed. New strong magnesium-zinc-zirconium and magnesium-zinc extrusion alloys have greatly aided expansion in use of magnesium extrusions, while 63S is increasing its importance among the aluminum alloys by virtue of the expanding market for extrusions made of it.

Brazed or welded assemblies now are used as a design form for both large and small parts. The technique of fabricating structures of high strength and toughness, superior rigidity and light weight from alloy steel plates and shapes by welding—a carry-over from wartime experience with artillery equipment, gun mounts, tanks, etc—is gaining in use for such things as heavy duty power shovels, truck chasses, and so on. Globe valves are also being fabricated by welding together shapes pressed from rolled plate, to give a lighter weight valve of the same strength as cast globe valves; the practice is good for valves larger than 5-in., but inferior to casting for smaller globe valves.

Stampings have been relatively "hard-to-get," primarily because of shortages of labor and materials for the process. The "Sol-A-Die" process for forming sheet metals (especially aluminum alloy and stainless steel) by a stage-die process [see MATERIALS & METHODS for November 1946, page 1168] is attracting increasing attention for short run forming jobs.

The precision forging of gas turbine

and jet engine buckets and of other parts (by Steel Improvement & Forge Co.), described in our September 1946 issue, opens up a new although somewhat specialized field for forgings, previously not considered a "precision" form. Other 1946 developments worth noting include the work being done on injection molded steel parts, the accelerating interest in contour forming and the development (by Pratt Industries, Inc.) of a new type of spiral tubing, specially formed from metal strip with edges joined in a continuous 4-ply lock seam.

Plastics

The best criterion of the state of the plastics industry as the first full year of peacetime production draws to a close can be found in figures. In spite of reconversion difficulties, labor difficulties, and material supply difficulties, there emerges the fact that nearly twice as much plastics materials went into the industry as last year. Some types have shown a tenfold increase in quantity during the war years, and look forward to another tenfold increase as soon as the necessary expansion of plant facilities can be accomplished.

In addition to the overall expansion of the industry, several new plastics, or new modifications of existing types, have been introduced during the year. One of the most interesting of these is Teflon, a development of the duPont Company. Teflon seems to promise to carry the working temperature range of plastics several hundred degrees higher, and, with service temperature limitations recognized as one of the sharpest handicaps of industrial plastics materials, such a gain is significant indeed. The upper limit of the temperature range is about 600 to 700 F.

The material is available in quantity as a granulated polymer, to be poured and cured in the forms. The present price is about $15 per pound. One of its first uses was as a gasket in the chemical industries, where advantage is taken of its combination of heat and chemical resistance. Its excellent electrical insulating properties have made it a motor insulating material for those applications for which its advantages offset its high price, and for high frequency insulation in radio and radar installations.

Another new plastic, Kriston, announced about a year ago, will become commercially available with the beginning of 1947. Heretofore this transparent thermosetting resin has been available in experimental quantities only. Possessed of sufficient clarity to make it suitable for optical purposes, and with the freedom from distortion conferred by its thermosetting quality, it is expected to figure importantly in several industries.

Kriston's ability to undergo cure without pressure is expected to make it of especial value in the field of low pressure laminating. Low pressure laminating techniques have made possible the widening of the field of applications of plastics in that they have removed many of the size limitations imposed by presses upon high pressure laminating. No definite temperature limit has been set for Kriston, an allyl-base copolymer, but it would be above 300 F, as the resin is frequently aged at that temperature.

The new resin will be too high priced to make it a competitor of any of the present general purpose phenolics, but the price picture is expected to improve after production reaches large volume.

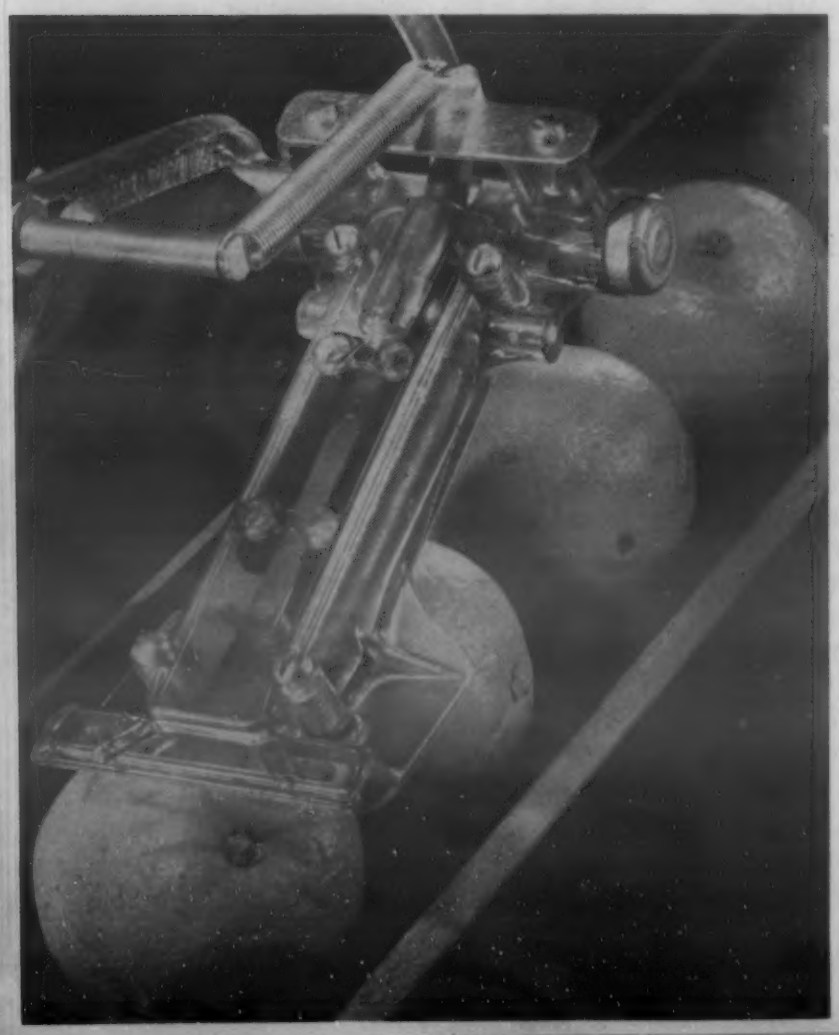
A new styrene copolymer, announced during the year and called Plexene M, possesses properties that may make it a competitor of some of the thermosetting resins. It shows good strength, high resistance to organic solvents, toughness, and stands up well when exposed to the weather.

Several new polyamides, members of that group offered under the trade name Nylon, were offered to industry during the year. These included molding powders, heavy sheet stock, and foils.

Perhaps the most active field in the plastics industry was that which included the developments of the vinyls. These resins, familiar to the public in such varied articles as shoe soles and shower curtains, were prepared as flexible sheet, thin foil, coatings for other materials, especially fabrics, and as latex suspensions in water. These suspensions have been mentioned as having great possibilities as surface coating materials. Other types of suspensions, in which the resin particles are contained in a plasticizer, or in which resin, plasticizer, and a volatile nonsolvent thinner are combined, may be used to produce sheet stock, film, or coatings without the use of extrusion and calendering equipment.

Low pressure laminating will be helped by the development of a combination material for this purpose. Resinous plasticizers and unsaturated alkyd resins, similar to those that have been used successfully in the new resinous lacquers, are combined with a vinyl, usually styrene, in laying up the plies for this type of laminating.

The cellulosics, backbone of the thermoplastic molding industry, have



Here Tenite is used as paddles of electrically operated citrus counters. This plastic material was chosen because of lightness and toughness.

been active also. Cellulose propionate, with exceptional toughness as one of its most interesting characteristics, was received into production schedules in quantity. A low-density cellulose plastic, offered under the trade designation CCA, cellular cellulose acetate, joined the rapidly lengthening list of cores for the sandwich materials. Cellular cellulose acetate cores have been faced with various plastics to produce an all-plastic composite, suggested for use in aircraft construction. (This, one of the year's leading plastics developments, is the subject of a feature article in this issue.)

New applications of silicones have carried them into the fields of high-temperature lubrication, into high-temperature bonding, and as elastomers, especially gaskets for high-temperature service. Added knowledge of their characteristics, gained by their use in industry for more than a year, is expected to result in a more careful fixing of the conditions under which they perform most suitably.

The general purpose phenolics, lowest-cost resins yet available to industry for a diversity of uses, were produced in combinations with some of the vinyl chloride polymers, and with some of the synthetic rubbers. The resulting materials show a considerable increase in toughness over the phenolics molded alone.

Woods, Rubbers, Glass, Other Nonmetallics

Among those nonmetallic materials other than plastics, many have entered the industrial field as substitutes for metals or other items in critical supply during the war years, and are now finding it necessary to justify themselves against the consumer's tendency to return to the materials they replaced. So far, this competition has not forced curtailment of production of any of the nonmetallics. One reason is that, even where return to the formerly used material is assured, as in the case of metal or plastic closures over fiber jar tops, the return to normal production of other peacetime goods has restored markets for the nonmetallic that were suspended when all-out production for war was decided upon.

Wood, fiberboard, glass, and other materials were frequently called upon to do service in applications for which they were not well suited, and even the most biased advocates for a given material are glad to see these uses dropped. In other cases the substitute material has proved itself, and has won a new place fairly and on its merits. The growing use of fiberboard, hard finished, for crating and palletizing is an example of this. The greatly expanded use of fiber products, as treated papers or as pressed boards, was due in part to the war-stimulated air express adopting it as an ideal lightweight packing material. It has now been accepted for such uses in packing generally.

Glass containers are showing a strong tendency to remain in the food container field, in spite of the return of the tin can. They are more corrosion resistant than metal, and their transparency adds to sales appeal of the food. Their greatest drawback has been their breakability, and the glass manufacturers are combating this in two ways, *i.e.*, by producing a more durable glass vessel, and by more careful packing methods for the filled containers during shipment. The metal can is still the most popular container for many foods, but the glass vessel has made substantial gains in the field.

A recent announcement in the glass industry tells of the production for civilian use of a coated glass that permits vision through the sheet from one side only. From the opposite side the glass functions as a mirror. A wartime development, the transparent-reflecting glass has been suggested for such uses as automobile glazing and panels in the doors of dwellings.

Porcelain enamelled bearings, made of steel with a coating of acid-resisting enamel, have been announced recently. A synthetic rubber sleeve fits over the journal, and the bearing surfaces then consist of rubber and enamel. Any sort of lubricant can be used, giving the bearing a decided advantage when danger of contamination with ordinary lubricants would exist. The new bearing can be used in direct contact with foodstuffs.

It has also been used to pump oil with a high sulphur base. The synthetic rubber is unaffected by the oil, and the enamelled bearing, unlike ordinary bearing metals, is not attacked by the sulphur.

A ceramic-metal material, made by sintering a compact composed of metal and ceramic powders, offers possibility of a magnetic, or heat conductive, or electrically conductive ceramic for industry. Manufacture of the new composite material follows the methods of powder metallurgy, the powdered ingredients being mixed, pressed, and sintered. While most ceramics are fired in an oxidizing atmosphere, the composite must be fired in a neutral or reducing atmosphere to prevent oxidation of the metal.

A new combined ceramic and thermoplastic called "Plastiform," developed by Duorite Plastics Industries, is one of a growing group of combinations of this general type; they are useful as tools and dies in aircraft work, coatings, electrical insulators, etc. Plaster-resin mixtures such as Mycalex, Plaspreg, Palestic, etc. are also receiving increased attention.

A process resembling the magnetic powder method for detecting flaws in steel has been produced for inspection of ceramics. The indicating powder is drawn into any surface cracks in the material to make them visible.

Development of rubber, synthetic rubber, and certain types of plastics known as elastomers as compound materials is expected to be accelerated by work just coming from the laboratories. This consists of compounding by formation of a "co-coagulum," in which the synthetic rubbers or other materials are made up as a latex, mixed in that condition, and then coagulated.

Another wartime development came to light with the announcement of wire recordings made on paper tapes impregnated or coated with metallic powders. Paper tape for masking has become a standard article in the paint shop, and in the machine shop for protecting easily marred surfaces during handling between machines.

Use of aluminum-paper foil is being expanded as a packaging material. This metal-paper laminate has been called "the perfect packaging material" by some engineers in that field, largely because of its light weight, effective moisture barrier, attractive appearance, and printable surface. Aluminum foil is being used as a laminate with various synthetic sheets also.

This prize-winning photograph of the oil quenching of steel was taken by Edward P. Truhn of Cornell Aeronautical Laboratory.

Processing Methods

In the many fields concerned with the processing of engineering materials, 1946 produced evolutionary progress rather than many advances of a startling nature. However, each of the fields covered in this report has shown signs which indicate that it is perhaps still too soon after the war to expect basic changes. Producers of most types of processing equipment have been too busy meeting demands for current models to pay complete attention to development or to perfect equipment designed during the latter stages of the war period.

Among the fields to be covered in this particular section of the MATERIALS & METHODS Annual Engineering Review are: melting and casting; rolling, wire drawing and extruding; powder metallurgy; forging; press-forming; machining; welding, joining and cutting; heating and heat treating; cleaning and pickling; finishing and coating; testing and inspection; and, instrumentation and the control of metalworking processes.

Melting and Casting

Increased labor costs during 1946 were an inducement to mechanize foundries and related plants to a higher degree. Inefficient methods involving hand labor are being eliminated gradually, as in the mechanical charging of cupolas. Also, during the year there was a careful scrutiny of melting and casting methods uncovered in captured German records. Through all phases of melting and casting there was a search for methods of saving money.

In open-hearth practice, double slag pockets have been studied here in an effort to lengthen furnace life, as was achieved in Germany.

There is a trend towards sounder ingots through a reduction in porosity. The Air Reduction Co. has a new process for bubbling dry nitrogen or argon,

thus eliminating porosity-causing hydrogen.

Promising is the outlook for an all-basic open hearth furnace, with many advantages derived from substituting a basic roof for the present silica roof. The use of oxygen in the open-hearth was found to save fuel, increase furnace life, reduce scale, and lower melting time. An increase in cost of about $1.25 per ton of steel melted is offset by increased tonnage. Further cost reduction is expected through improved oxygen production methods. It may be possible to operate with oxygen and eliminate checkerwork, resulting in a great decrease in furnace cost.

Increases in ingot production of 20 to 35% have materialized when pure oxygen was used with fuel in the melt down in the open-hearth. The pig iron percentage in the charge is materially decreased. Too, it is possible to reduce carbon content, say 0.50 to 1.50 to 1.0% carbon, in a few minutes. There are at least six problems, too extensive to discuss here, involving oxygen. Within a few years oxygen will be used regularly in blast furnaces, after necessary redesigns have been made.

In foundry melting there is a tendency towards stricter moisture control units since decomposed water increases carbide stability, produces chill spots, and makes for porosity. Of promise is the basic-lined cupola which reduces 0.12% phosphorus and 0.07% sulfur down to 0.03% each. A metallurgical trend in malleable iron is toward much lower carbon content, which improves physicals and opens a much wider field of application. There has been a great increase in use of cupola-air-furnace duplexing for production of malleable castings.

"Inoculated" or "treated" irons are gaining in popularity, having desirable properties, but their production requires good melting practice, technical supervision and considerable control.

Noteworthy during 1946 was the first U. S. installation of electronic frequency converting equipment for production melting of alloy steels at the Michiana Products Co., Michigan City, Ind. The pioneering was done through Allis-Chalmers. It is good for low carbon alloys such as stainless steels where machinability is the primary factor. The operator is eliminated since the electronic equipment automatically changes frequency as the steel melt progresses.

Receiving attention in the electric furnace field is the method of changing oxidizers, fluxes and recarburizers with the scrap so that bath and slag composition will be correct when the heat is melted. The basic electric industry is experimenting with several methods of reducing heat time and power costs (as compared with those of the basic open hearth). The present best possibility is refining for a very short period of time under a final deoxidizing slag containing up to 2% ferric oxide, instead of taking time to reduce iron oxide to a negligible amount. Other methods tried are: refining under a single oxidizing slag, and refining under the same slag plus a partial deoxidization of the slag at the end of the heat.

A new method for making certain castings sound and free from shrinkage has been developed. Large quantities of exothermic powders are used in risers to guarantee directional solidification. Such powders must be compounded to match the metal to which they are to be added. Iron oxide with aluminum, properly graded as to particle size and toned down to the proper heat level, is suitable for steel. For Monel metal, nickel oxide, copper oxide, aluminum powder, etc., control the heat level and viscosity of the slag.

Electronic heating for baking sand cores adds to quality and mass production. New thermosetting resin binders have been developed for this application.

In centrifugal casting the most recent development is a method of applying this process to gray iron. In Germany metal molds for centrifugal casting of steel gun barrels and heavy tubes were faced with a layer of fine sand spun on the mold wall. This technique served to protect expensive molds and increase production without overheating the molds.

An expert points out that a magnesium casting superior to a static casting can be made successfully by the true centrifugal permanent mold process. Such a casting has improved tensiles, is cheaper to produce, and shows improvement in grain size because of the chilling resulting from close contact with the mold walls.

In the die casting field the most striking development was the use of the process to make aluminum motors. No existing machines were large enough to produce parts of the size, intricacy, accuracy and density desired, so a machine weighing 75 tons was built. The machine contains 300 parts, exclusive of studs, nuts and bolts. The die for the aluminum motor block weighs 14 tons and has many features which remain unrevealed for the time being.

New high pressure die casting machines for casting magnesium, aluminum and copper alloys, made by Hydraulic Press Mfg. Co., are of revolutionary design in that mold clamping, metal injecting, core pulling and ejecting units are all operated by direct hydraulic means.

Cost of production of small die castings has been reduced and output greatly increased by use of a large, square die block upon which are mounted four separate dies. The smaller unit dies are all of standard size so that any four dies can be used to produce a cluster of four of the same parts, four entirely different parts or any combination in between.

Reported during the year was the development of a machine for injection molding of steel, a process that is akin to die casting. As yet we have not been able to locate any users of the process in this country, although it is known that a few such machines have been built. During the war such an injection machine was built here and shipped to England for use in producing hollow hypodermic needles. Several prominent U. S. companies are awaiting similar machines with which to experiment.

Melting and casting are combined in one unit, a casting machine and a 10-kva. high frequency converted developed by Alexander Saunders & Co., New York, and used for precision investment casting.

Rolling, Wire Drawing, Extruding

In rolling there is a tendency to modernize old mills rather than to build new ones, and the emphasis is primarily on greater speed. Some cold reduction mills operate as slow as 150 f.p.m.—one modern one at 3,850 f.p.m.

Speeds of strip mills are being stepped up 50% over prewar. Rod and bar mills will be more rugged in design to take heavier drafts. Tube mills are being stepped up 30% in speed.

The trend is in the direction of single purpose mills, say one for tin plate, and one for sheets. Electronic controls are being widely applied—amplidynes control generators, generator voltage, load balance between twin drives, control the tension reel, ohmic-drop compensation and indicating tensiometers. New, too, are high-speed counting devices, X-ray thickness gages for electrolytic tinning.

On one of the most modern electrolytic tin-plating lines, motors are installed in pairs, one to drive the upper roll and the other the lower roll. The motors are d.c. with heavy dropping speed so they will slow down if one should operate faster than the other, rather than slip the roll on the metal.

The world's first continuous seamless pipe mill is being built to turn out long lengths of pipe at 2,000 f.p.m. The usual five operations in seamless tube manufacture is being combined into one in this plant at Lorain, Ohio.

Kennametal, Inc., has developed a solid tungsten carbide roll for cold metal strip mills, with high strength, hardness and modulus of elasticity two or three times that of steel. Its uniform, close-grained structure gives high polish to both rolls and strip. It is now working on nickel strip, but is also good for carbon and stainless steel. Mackintosh-Hemphill Co. has introduced a "Nitronite D" roll, working faces of which have a sclerescope hardness of 85 to 90.

During the year it was demonstrated that magnesium ingots can be rolled into sheets on mills designed for steel with only minor, if any, adjustments.

Wire Drawing

In wire processing there is a tendency to eliminate the old-fashioned "sull and lime" coat in favor of coating compounds that have an alkali base, plus resinates, phosphates, silicates, borax, or combinations of these materials. Most are claimed to be corrosion resistant, although some are not. There is some question as to their value, although they do speed up the process and eliminate all the lining after coating. One expert states that there is more scraped and out-of-round wire produced with the new style "no-lime" than by older methods.

In copper it is becoming a "must" to make small sizes of magnet wire, 0.003-in. and larger, from rods that are shaved. A tentative process for many years, it is now here to stay and is practiced by 20 wire mills. The shaving eliminates all oxides, slivers and other defects. The trend in the direction of stainless steel for wire products — particularly 18:8 — progresses fast. The 1946 stainless wire output set a record.

It is generally recognized that diamond dies are used for drawing the smaller wire diameters, while carbide dies dominate the large wire field. Now, according to Carboloy Co., steel wire as small as 0.005-in. is being drawn through carbides. The general commercial limit is 0.010 in. Some low carbon small steel wire is now being drawn as fast as 2,200 f.p.m. As to comparative speeds between steel and carbide dies, speeds of 300 to 400 f.p.m. for steel dies compares with 1600 f.p.m. for carbide dies.

Jones & Laughlin, Wire Rope Div., has installed Thy-mo-trol wire winding units which triple production per winding line. They are now winding over 4,000 miles of wire in 24 hr.

Extruding

Developments in extruding were most conspicuous among the light metals. Major advances have been in the newer alloys among the light metals.

It has been reported that discovery of a German method for the cold extrusion of steel shapes may open up an entirely new field in ferrous metal processing. The process was developed during the war by two German firms where cartridge cases, airplane landing gear cylinders and fuse bases were extruded from cold steel. Steel which has been bonderized is made to flow under pressure into specially designed dies and molds. Many annealing, pickling and machining operations are eliminated. The phosphate treatment serves as a lubricant and lubricant carrier.

In the light metals field, during 1946, the commercial demand for magnesium extrusions became firmly established. The anticipated slump following the cancellation of war requirements never materialized, and by the second quarter of 1946 the backlog of orders exceeded that of war years.

Compared with the prewar period when Dow Chemical Co. and American Magnesium Corp. could alone more than supply the demand, the facilities of these suppliers are now taxed to capacity, as are those of White Metal Rolling & Stamping Co. and Revere Copper & Brass Co., both of whom started extruding magnesium during the war. In addition, the National Magnesium Co. is now installing extrusion presses and will soon be in operation.

Powder Metallurgy

With the sudden cessation of war production, the making of parts from powder metals dropped to an extremely low point late in 1945 and early in 1946. However, activity continued among producers of powder metal parts to find new uses for their products, improving production methods and widening the range of materials used.

One outstanding development which makes use of what are in effect powder metals is a method by which steel chips resulting from a machining operation are used to produce automotive parts such as bearing lock sleeves. One such product, made from SAE 1112 steel, has a hardness of 78 to 90 Rockwell B and can withstand a minimum load of 2500 lb. before fracture.

Dry chips from the machining operation are shredded to reduce their size. The small chips are then briquetted under 400-ton pressure. Final inside dimensions are reached in this operation. The brittle briquettes are then heated to 1850 F in a controlled atmosphere furnace. This operation is simply to aid further forming, so parts are held at heat for only 15 min. Next the hot parts pass through another press where the outer dimensions are formed. The effect of this operation is to provide the necessary dense structure. Trimming and cold-coining complete the parts.

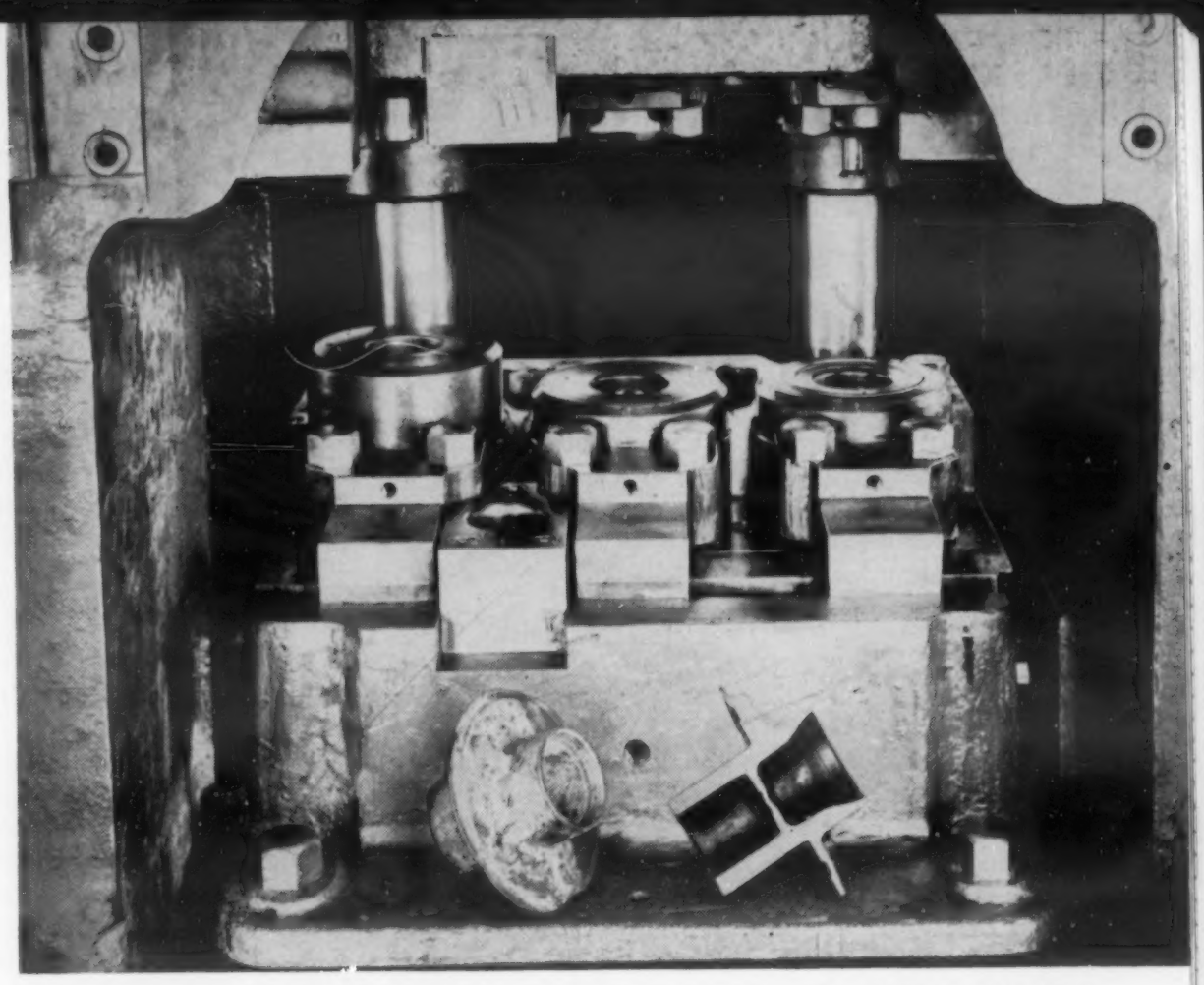
During the past year information was published on the use of ultra-fine

metal powders in producing high density parts at relatively low pressures. Results show that high hardness can be achieved in parts when such powders are used. However, it was learned that such powders when used alone have poor flow characteristics. Thus, ultrafine powders become most valuable when mixed with larger particles or in mixing alloyed or composite parts.

Carbusintering is the name applied to a new method which combines sintering and pack-carburizing. Iron powder is compacted at various pressures, packed in a carburizing compound and sintered at 1700 F for periods of 2, 4 and 8 hr. Investigation showed that best results were obtained with a sintering period of 4 hr. With an iron powder that, processed by standard procedures, gave a hardness of Rockwell 13 B and a tensile strength of 13,000 psi., the following physicals were achieved: hardness (as quenched in water), Rockwell 52 C; tensile strength, 66,000 psi. The case depth resulting from this method was 0.04 in., with a case carbon content of 1.25%.

During the year many reports on German practice in powder metallurgy became available through government agencies that have sent technical missions to Europe. Nothing of a particularly startling nature has yet been revealed, although additional reports continue to be made public.

Since it has been proved that powder metal parts can be made of materials that resist the effects of wear and high temperatures, investigations are continuing in this field. Particular interest is shown in the possibilities of using special powder combinations for such parts as turbine blades, supercharger buckets and the like. One possibility which seems near to realization is the use of metal powders bonded together with ceramic or refractory materials.



Typical press forging die for producing truck hubs in four blows at one heat. The forging is almost entirely pierced to help reduce its weight.

Forging

As has been true in past years of this, one of our oldest metal forming operations, forging showed some progress during 1946 although most such development was in the nature of refinement in processing rather than being of a revolutionary nature.

One development which is likely to have a rather far-reaching effect is a method of forging rounds of high alloy steels in diameters up to 12 in. Previously, the practical size limit was 5 in. and below. Barium Steel & Forge, Inc., with the cooperation of the metallurgical staff of Jessop Steel Co., perfected the process which can be carried on with either hammer or press forging equipment. Normally, rounds are produced by converting square billets progressively by means of flat dies through hexagonal and other multi-faced shapes until a round shape is achieved. On large sizes, this method resulted in high scrap losses because of center rupture or burst and in faulty steel because of improper carbide distribution. Barium's new method involves use of a flat top die and a V-shaped bottom die. The V-shaped die restricts sidewise spreading of the billet and reduces by half the strain characteristics normally caused by the forging action.

Atmosphere forging which has long been advocated has now become a reality, and details of a few of the installations previously made are now becoming known. One installation involves the forging of steel of comparatively thin section. Because of the limitations involved in the product, it was highly important that there be no scaling, surface irregularities or decarburization. Controlled atmosphere furnaces are installed adjacent to each forging press. The metal is heated to forging temperature and then one blow of the press is struck. Then, between each subsequent blow, the metal is reheated. When necessary the parts are cleaned between forging blows so that if any slight scale appears during the separate blows it is not hammered into the surface.

Forging equipment continues to increase in size. Recently there was installed an 18,000-ton die forging press which is intended largely for producing massive magnesium and high alloy aluminum forgings. Since these materials require somewhat special treatments in forging, the press is designed with heat-treating and auxiliary equipment that is specifically adapted to this application. Forgings up to 12-ft. long and 6-ft. wide can be handled on this press, which was engineered and built by Mesta.

There was no new forging equipment announced during 1946 that represented a basic change in the process, although both methods and equipment were improved so that press forgings could compete with hammer forgings, as well as castings, on large, heavy parts. For instance, parts that reach a

diameter of 9 ft. or more or that weigh upwards of 2 tons are not too rare.

Perhaps improvements in the older types of forging equipment, board hammers in particular, have come about because of the surge of other methods. Regardless of the reason, board hammers have been improved in design so they are capable of handling many jobs where close tolerances are necessary, or where competitive conditions require that parts that are forged entail a minimum of machining to bring them to final size. For here, too, it has been found that higher costs of precision built equipment and carefully designed dies are more than offset by reduced costs resulting from lowered scrap losses, less material waste and, finally, less machining.

The forging of brass has been vastly improved by the development of special equipment, and by a combination of operations whereby extruded brass shapes are finally forged to final shape. There are relatively few brass forgers, but the reduction in cost through improved forging methods makes possible the more widespread application of brass.

Stamping, Drawing and Pressworking

Stampings and other pressformed parts continued during 1946 to move into fields once considered almost sacred to other processes. Particularly noteworthy is the large-scale production of bathtubs and other large bathroom and kitchen equipment. With the exception of special products of this nature made of stainless steel and Monel, most such tubs, tanks and sinks were castings. The change of production methods comes primarily for two reasons. First, the terrific demand for housing led to a need for such items that was impossible of being met by the foundries. Second, the large press capacity of the country sought something to keep itself busy and to make use of the enormous technological advances resulting from the war.

1946 also saw many builders of boats, canoes and other pleasure craft resort to stainless steel, plywoods and the light metals for their products. All of these materials can and are being formed in large sections by means of presses. Heated dies are required for the forming of plywoods, but likewise such dies are also required for magnesium.

Both of the previously mentioned facts would seem to indicate that many more materials can be considered for a wide variety of products. In other words, restrictions once imposed by tradition, which required that certain products be produced by only one method, are now passing into the discard.

One of the newer pressforming operations is the bulging of metals in hydraulic presses. An outstanding example of the type of work done is in the making of stainless steel dairy equipment by International Harvester Co. In this operation segmental dies are employed for facility in loading and unloading work. When pressure is applied, the dies form a seal around the mouth of the drawn part. After sealing, hydraulic fluid is allowed to flow inside the piece and fills it out by forcing it against the dies. Pressures up to 3,000 psi. are used here. Bulging is used to produce a cylinder which is narrower at the mouth than through the body.

Bulging is also employed to make parts of aluminum alloys. Here the high strength alloys are found to be much more readily formable if they are heated to about 400 F. Pressures, as with stainless steel, are up to 4,000 psi.

Piercing or perforating of sheet metals in presses has come in for considerable attention during the past year. In such operations holes or slits are punched through the metal with punch and die sets. Most materials including aluminum, brass, nickel, as well as stainless, carbon and high strength steels can be thus processed. One example of perforating is a case where more than 600 staggered holes 0.031-in. in dia. are punched per sq. in.; another requires 3/32-in. holes on 5/32-in. centers, with 35 holes per sq. in.

One new press designed specifically for perforating has a capacity of 75 tons, will take sheets up to 40-in. wide, and provides a range of from 180 to 360 strokes per min. Much of the success of perforating on a production basis depends on the press feeding mechanism. The press provides feeds in increments of 1/64 in., with a maximum feed per stroke of 5/8 in.

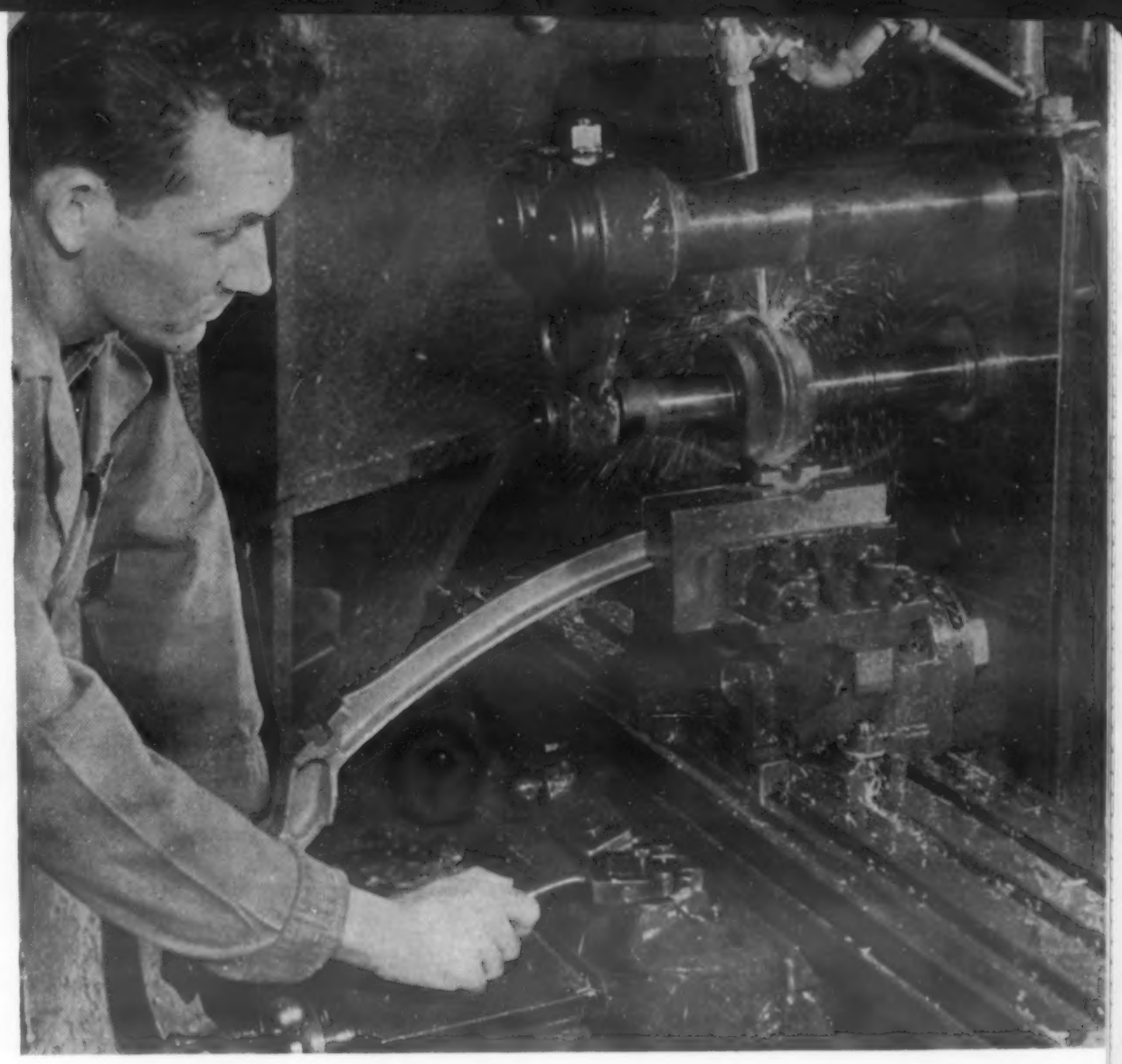
Drawing and piercing are combined in a new single-action hydraulic press of 1500-ton capacity which is being used to produce stainless steel evaporator plates for home refrigerators. The same press also can be used to produce blanked, stamped, formed, trimmed and embossed parts from sheet metal.

It has been determined that sheet steel is formed by the Guerin process on hydraulic presses as satisfactorily as aluminum alloys and more easily than some. In this process, rubber pads replace the upper dies normally used on presses. Corrosion-resistant steel up to 0.050-in. thick and ordinary automotive body steels as thick as 0.156 in. are readily formed in this way. In addition to being suitable for the forming of parts of relatively simple contour, this method is likely to be used widely in the starter stage for parts of more severe contour. Forming can be done over cast phenolic dies for smaller parts and Kirksite for the larger pieces.

Producers of stampings are learning to produce parts of stainless-clad steel which is surprisingly easy to form. With the clad material, one draw is often sufficient as compared to two or three if solid stainless were being used. A big source of stamped and drawn parts of clad materials is expected in the automotive industry, which is already using them for bumpers and similar applications.

Machining

Many of us, it seems, were looking forward to a rash of new and startling machine tools and machining methods to appear during 1946, but to a large extent there was little realization of this expectation. There were some new ideas put before the metalworking public last year, but with rare exceptions builders of machine tools were too busy meeting demands for current models to devote much time or effort to new development.



More fabricators will become accustomed to machining magnesium and its alloys. This photo shows radius milling of a magnesium alloy part in the Warren McArthur plant.

One of the outstanding new ideas is the Mult-Au-Matic spacer for use on sensitive and radial drills. The spacer, when it becomes widely applied, will do much toward the elimination of drill jigs. Most any arrangement of holes can be made within the range of the device and automatically repeated as often as necessary. (This method is fully described in a separate article in this issue of MATERIALS & METHODS.)

A new lathe introduced by the R. K. LeBlond Machine Tool Co. is provided with dual drives which provide 12 spindle speeds. The top four speeds—of the range required for the best utilization of carbide tools—are by direct belt drive. High speeds are 540, 782, 1140 and 1800 rpm. Low speeds attained through a gear train are 28, 41, 60, 95, 134, 193 and 445 rpm. All spindle speeds are controlled by a single lever.

Also developed in the line of lathes of Monarch Machine Tool Co. is a simplified version of the conventional lathe base and headstock which uses from one to three special motor-driven toolslides to permit turning, facing and boring operations from almost any angle.

All types of cylindrical, flanged and conical parts can now be produced by a method known as roto-shaving. By this method both work and tool rotate and through such operation it is possible to remove up to 0.020-in. of material. Parts to be processed by roto-shaving can come to the machine in the rough machined state and finished to grinding tolerances with surfaces as smooth as those obtained through green grinding.

Carbide-tipped hobs have been applied to the machining of phenolic laminate gears with highly successful results. Although such hobs cost about three times as much as high-speed steel hobs, life between grinds is extremely high and output is approximately 40% higher.

Other phases of machining have taken steps to extract all the advantages inherent in carbide tools. Two major producers of milling machines have extended their lines to include millers designed specifically for carbide milling. Such machines are of heavier construction than standard models, have more powerful drives and heavier spindles. Construction of the millers provides the fly-wheel effect necessary to the most satisfactory carbide milling.

Too, solid carbide drills have now been made available in the smaller sizes. Such drills are particularly suited to working on cast iron, brass, bronze, magnesium, aluminum and most non-metallic materials.

So that small pieces can be milled faster, a new milling machine has been made available which provides two spindles, each independently driven. With such a machine two opposite surfaces of a small piece can be machined at the same time. Spindles are horizontal and opposed and have independent vertical adjustments, whereby cuts can be taken at different relative heights.

A faster method of producing straight bevel gears is provided by a new machine known as the Revacycle. By the Revacycle process, bevel gear teeth are generated from solid metal in one cut. In this machine the blank is held motionless while the cutter rotates in a horizontal plane and turns continuously at a steady rate. Tooth form is attained by a combination of the cutter's motion and its shape. The cutter contains roughing, semi-finishing and finishing blades.

Centerless thread grinding has simplified the production of numerous threaded parts whether straight cylinders or headed pieces. By the use of centerless thread grinding it is now possible to thread iron powder metal parts—something that was not possible on a production basis in the past. The only centerless thread grinder yet available uses the crushed wheel method of forming threads so the machine is provided with an automatic crushing dresser.

During the past few years there has been considerable attention paid to methods of duplicating difficult dies, molds and other products through the use of tracer controlled mechanisms. Most such work has been done on milling machines and die sinkers, but now tracing mechanisms are being widely applied to lathes. Several lathe producers have developed their own systems of following, but others have adapted existing mechanisms. Steps, tapers, curved surfaces and the like can now be produced on lathes speedily and with little need for skilled help other than that required to turn out the original part or make a master ternplate.

Welding, Joining, Fastening, Cutting

This diversified field continued to progress steadily with the introduction of some completely new developments and further refinement of older advances. In the field of metallic arc welding, principal advances seem to be in the application of improved types of electrodes developed previously. The ferritic electrodes, which underwent the initial development work during the war, saw increased practical use for welding materials such as hardenable steels, cold rolled steels, high-sulfur free-machining steels used in mold and die work, steel castings and high carbon steels. The electrodes consist of a mild steel core wire and a coating similar to that used on stainless steel electrodes. Their outstanding characteristic is the ability to deposit weld metal with a minimum generation of hydrogen. Two types are now generally available: one producing weld metal of about 60,000 psi., and the other giving higher strength welds of 90,000 to 100,000 psi.

Another new type of welding electrode, developed in Holland, combines the characteristics of touch welding, self starting and re-ignition. The welding technique using this electrode is called contact arc welding. The electrode has a very heavy conductive coating. A great part of the iron from the core wire is contained in the coating, and this iron is deposited in the weld. In welding, the electrode is held in direct contact with the work piece. When welding by this method, particularly in the flat and horizontal positions, there is less fatgue, and, because of the special form of penetration, undercutting is minimized. Also, heavier electrodes and currents can be used in many cases.

In order to eliminate hot cracking in the welds of manual arc welded nickel-chromium-iron alloys containing 35 to 80% nickel and 15 to 20% chromium, an electrode of nickel, chromium, and iron with some columbium was developed. It was found that silicon was the responsible factor for the hot cracking and that the introduction of columbium into the weld in a ratio directly proportional to the silicon content would eliminate the cracking. Another new welding rod was developed using high nickel alloys for the making of machinable welds in cast iron.

Marked advance has been made during the year in the application of the inert gas shielded arc welding process. First introduced during the war, the equipment has been improved and welding procedures developed for virtually all metals and alloys. The process employs the use of a tungsten arc operating within a shield of inert gas. Helium was originally used; later argon was introduced and now is widely employed, one of the chief reasons being its comparatively low cost. Also, in the welding of aluminum, no flux is required with argon. In welding other metals and alloys no flux is required when using either helium or argon. Some investigations were conducted to determine the relative quality of welds produced using argon and helium, and the results of one such investigation seems to indicate that a helium shield produces superior results on virtually all metals but aluminum. However, this question has not yet been answered conclusively.

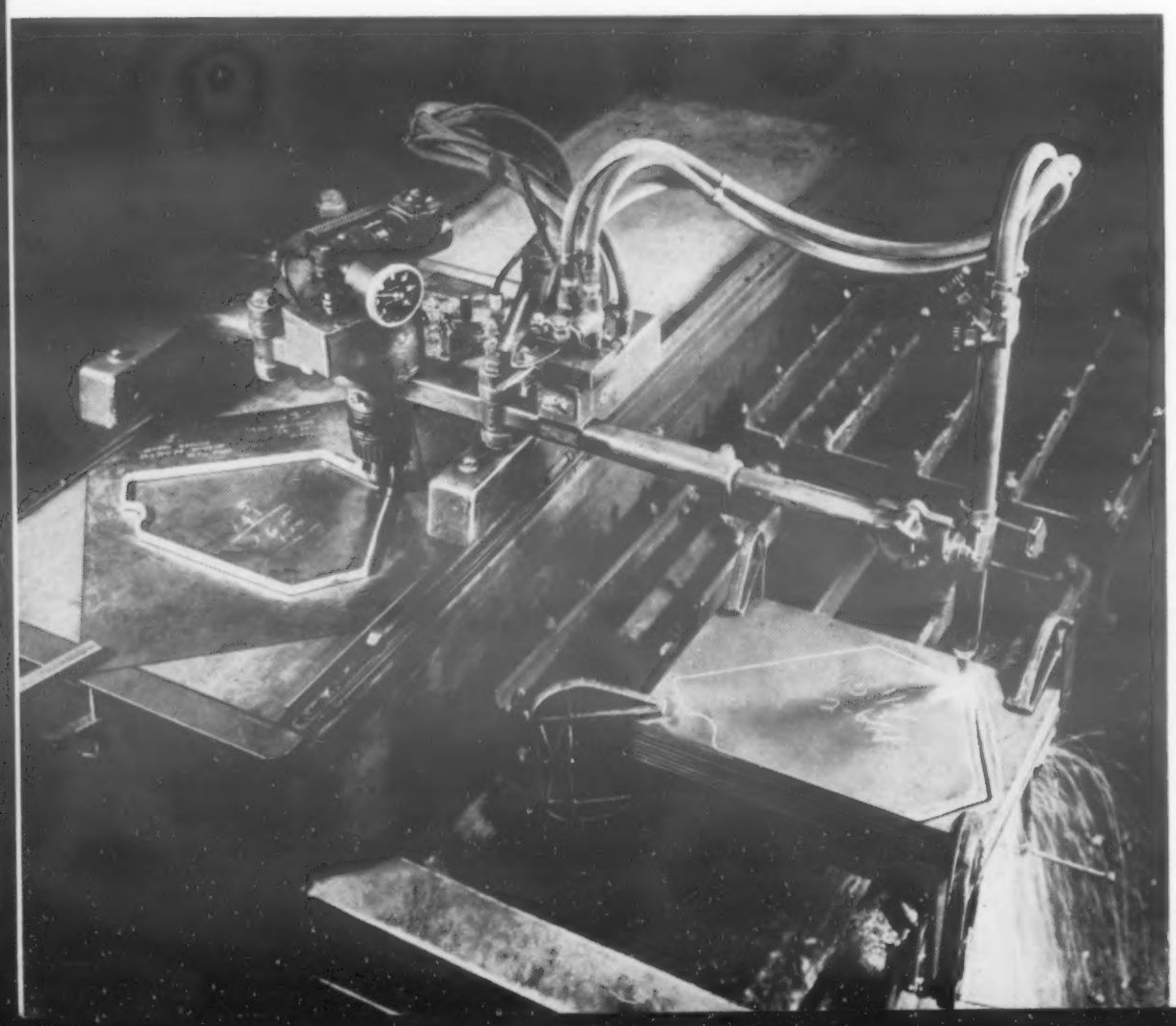
In the field of resistance welding most developments were in equipment improvements. New, larger and fully automatic welding machines were built to meet special production requirements. Multiple-electrode spot welders are now being built with as many as 100 pairs of electrodes. Further advance in the use of storage battery power for resistance welding was made with the development of a storage battery specifically designed for this purpose.

Three different methods for cutting ferrous and nonferrous materials were introduced during the past twelve months or so. All three are a significant achievement and will solve one of the most bothersome problems encountered in many metal processing operations. Perhaps their biggest application is in the cutting of stainless and other alloy steels.

The powder-cutting and scarfing process developed by Linde uses a finely divided iron-rich powder, which is ejected into the oxygen stream, burns, creating a high temperature reaction to cut the material. The process is applicable to cutting or scarfing practically all ferrous and nonferrous metals.

In the method developed by Air Reduction Co., a chemical flux is fed through the oxygen stream to react with the refractory oxides of chromium and nickel rendering possible the cutting of stainless steel.

The third method developed by Arcos Corp. uses a fine point concentration of heat generated by an electric arc and a stream of oxygen. The arc is established between a coated tubular rod (consumed in the operation), through which the oxygen flows, and the metal being cut. Practically all the metals commonly used for fabricated



Templet guided flame cutting equipment has become an increasingly popular method for producing quantities of irregular flat shapes. (Photo: Courtesy Linde Air Products Co.)

parts can be cut. (Complete details of this development are given in a feature article in this issue of MATERIALS & METHODS.)

Interest continued high in hard surfacing as a means of maintaining and prolonging the life of wear resistant parts. Hard surfacing also saw widening application in the initial production of wear resistant parts; the design of many such parts now specifies a hard surface overlay. Many new hard surfacing rods were introduced, but there were none that might be considered as new and distinctly different. A powder dispenser unit for semi-automatically applying granules of crushed tungsten carbide on base metals was announced and is still in the development stage.

Several unique methods of applying hard surfacing materials were brought forth this year. In one of these, compositions of powdered metals together with suitable fluxes are projected through the flame of a specially designed torch onto the work surface. The method is also said to be applicable to welding and brazing.

In two other processes the hard surfacing alloy is either sprayed in powdered form through a newly developed powder metallizing unit, or a special plastic-bonded rod is fed through a wire metallizing gun. The overlay of the hard surfacing material is then bonded to the base metal by either an oxyacetylene torch, induction equipment or a controlled atmosphere furnace.

In mechanical fastening, research projects continued on the very common problem in industry of bolt failures during fabrication. One such investigation reached a conclusion that in a failure the bolt is pulled off rather than twisted off. Projects are now under way to determine just how much torque wrench effort should be applied to obtain the optimum clamping force for ordinary sizes of low-carbon, rolled thread bolts.

Early last year, standards groups in the United States, Canada and Great Britain agreed on the unification of screw thread standards. The new unified basic form of thread has an angle of 60 deg. and a rounded crest and root.

An alloy steel rivet developed during the war for military aircraft is now going into commercial planes, truck trailers and other civilian items. The rivet is a combination of a heat-treated alloy steel body and a deformable aluminum collar which permits the deformation necessary for riveting without altering the high strength body of the rivet.

Heating and Heat Treating

Perhaps the most significant aspect of recent progress in the heating and heat treating field is the trend toward mechanization of the processes. The old concept which had all the heat treating operations performed in one location and often separated from the production line is being discarded and the mass production technique is being applied. For example, in the production of machine gears a particular section of the heat-treat department is located in the production line wherever the sequence of manufacture requires a heat treating operation.

This new trend calls for advances in control, methods and techniques of heating, and work handling. During the past year, the equipment manufacturers have been preoccupied in fulfilling these needs. There have been many improvements and developments in automatic handling equipment for large production heat treating of parts, large and small. New heating techniques by induction, liquid bath, and fuel fired method and electronic instrumentation for more accurate and versatile control of the processing have been perfected.

Applications of controlled atmospheres to production heat-treating operations have also been extended during the past year. In many cases older batch and continuous furnaces of non-atmosphere type have been redesigned for use with atmospheres. Design improvements include maintaining gas tightness, closer control of temperatures and gas compositions. These improvements have made it possible in some cases to obtain chemical and physical characteristics in parts made of low-alloy steels (and in some cases plain carbon steels) at least equal to those obtained with steels of higher alloy content formerly used.

The use of "carbon restoration" processes for *restoring* carbon to the surface of decarburized steel is increasing by leaps and bounds, and is one of the outstanding trends in steel treating. Also outstanding in the field of atmosphere generation is the new Neutralene gas producer which manufactures Co_2-free, dry combusted gas atmospheres for the *prevention* of decarburization during heat treatment. This unit is more economical to install and operate than previous units and occupies but a fraction of the space formerly needed for such equipment.

During the past two years extensive research work was devoted to a study of the carburizing process. The results, which include the complete knowledge of the chemistry involved in carburization, can now be used for production applications. It is possible to determine the exact atmosphere composition and other factors necessary to produce any desired surface characteristics in steel parts by carburization.

Another significant development in carburization is the new technique termed "suspended carburization." It is possible with this process to leave the work in the carburizing furnace up to 72 hr. without change in physical characteristics. Thus, where work schedules or other circumstances are such as to prevent removal of the charge after the normal treating period, this technique can be used.

The past year saw wider acceptance and more general understanding of the martempering and austempering techniques. These two processes have now definitely passed beyond the experimental stage. Intricate shaped tools and dies can now be heat treated with minimum distortion and no cracking.

High interest in the use of stainless steels placed emphasis on the development of improved furnaces and methods for annealing stainless steel. An improved salt bath method has been developed. Previously the annealing of stainless steel required two operations: annealing and descaling. By utilizing a specially designed salt bath, operating at around 1850 F, the material is heated to the desired temperature without oxidation; any initial scale present is removed during the heating and quenching period.

Another advance in salt bath heat treating was the development of a

In this special multiple spot welder, electric eye rays activate a battery of welding electrodes. An almost unlimited number of combinations can be worked out. (Photo: Courtesy Pullman-Standard Car Mfg. Co.)

rectified high-speed-steel-hardening salt bath. Previously, high temperature salt baths had a tendency to decarburize the steel surface; this was eliminated by using a graphite rod which furnishes the necessary carbon to reduce the objectionable oxides in the bath, thus preventing the use of carbon from the steel.

There have been no outstanding new methods or equipment introduced for heating of steel for rolling and forming operations. Interest continues over the comparative advantages of ingot heating furnace types—the regenerative pits and the various types of one-way fired pits. There has been recent agitation in favor of further simplification of one-way fired pits. The increased use of rotary hearth furnaces for billet heating, which gained impetus during the war, continued.

Although there were no major new developments in induction heating, this method of heating found many new and varied applications in the melting, forming and heat treatment of metals as well as in the laboratory. Induction heating for forging is particularly increasing in popularity. Refinements such as automatically timed heaters and conveyor systems for induction heating were also introduced.

Another refinement was the introduction of the use of flexible leads making the equipment more portable so that it is possible in many applications to move the induction units to work pieces. Within the past two months a portable gun-type induction heater was announced by Tocco. This device is designed primarily for heating parts which cannot be efficiently set-up in standard induction heating equipment. It can be used for heat treating small parts or spot areas, for brazing and other heating jobs.

Important is the introduction of a new internally heated salt bath furnace which is designed to provide automatic renewing of electrodes which are permanently sealed in among the refractory matter at the bottom of the furnace. Perpetuation of electrodes is said to be achieved by utilizing the chemical action between oxides and graphite rods in the bath.

In quenching, dilute caustic soda solutions have proved successful for use with many forged steel parts and in the heat treatment of water-hardening steels. In those places where such solutions have completely replaced water as a quenching medium, the following advantages are claimed: rapid heat withdrawal, more uniform results, and relatively low cost. (A description of this quenching method as employed by two companies is included in the feature article section of this issue of MATERIALS & METHODS.)

Cleaning and Pickling

A continued, steady and natural advance in improvements of equipment and techniques, and in the formulation of cleaning materials marked the metal cleaning and pickling field. The trend is toward the solving of specific problems because the multiplicity of metals and alloys and their treatment is recognized. Another noticeable trend is toward a more scientific approach to cleaning problems. There is much uncorrelated information on the subject which groups, such as the A.S.T.M. committee on soaps and other detergents, are now in the process of evaluating. Their object is to provide methods and specifications for the cleaning industry.

In most cleaning processes, and in pickling, preference continued high for equipment which is completely automatic and adaptable to various cleaning cycles. Some of the machines developed can be used as a single stage washer, or can handle a number of successive operations, such as alkaline, acid, or neutral. They can also be changed to take care of a series of different operations such as washing, rinsing, drying, pickling, and cyanide treatment.

It has been found that where there are a relatively large number of processes through which the work must go

the length of a regular conveyor machine becomes excessive. In this type of work a "grasshopper" type machine is being adopted. The work is loaded into crates or hung from fixtures. These are then put on conveyor chains and advanced automatically through the various processing steps. Because a large amount of work can be put in a crate or on a fixture with a minimum of surface area, the size of the cleaning machine can therefore be kept within practical limits.

In electrocleaning, investigations as to the nature of the surface of electrocleaned steels were conducted by diffraction methods. It was learned that a "clean" metal surface is actually filmed with some chemical compound of the base metal, or some compound of elements in the cleaning solution.

A number of cleaning compositions were introduced last year. A majority of them are specially designed for specific operations. Among them are self-emulsifying, water-mixable solvents for light cleaning of steel and aluminum; soak tank cleaners for cleaning aluminum alloys before anodizing, phosphatizing and other operations; special pickling and descaling compounds; and a solution for pickling aluminum and aluminum alloys that eliminates the acid hazards. Emulsion cleaners were more widely used to replace chlorinated solvent degreasers because of the chlorinate solvents shortage.

In blast cleaning, much of the work this year centered about the development of equipment of the semi-automatic type. The machines in most cases are employed to convey or carry the work to and through the blast stream in a manner so as to turn the work over and over to present all the surfaces of the work to the blast streams. The revolving and advancing of rods—round, hex or square—through a centrifugal blast stream is another equipment development.

Common to all blast machines is the function of cleaning the abrasive for reuse. Removal of sand and fines from the spent abrasive is now possible by an air wash method and eliminates the use of troublesome screening.

Precision tumbling, an important development of recent years, continued to be applied to deburring operations on a wide variety of parts. This process has the advantage of removing sharp edges without damaging the surface and at the same time controls dimensional loss.

Sodium hydride has been applied on hard-to-clean jobs in which iron oxide scale is involved. By the sodium hydride method this type scale is reduced to "sponge iron." First used on stainless steel, this method of cleaning and descaling has been extended to many other ferrous alloys, although it will not entirely replace sulfuric acid pickling, especially on cheap grades of steel wire, where both methods now apply.

Finishing and Coating

The recent years have seen finishing take on new and added importance in the metalworking industries, and this past year was no exception. Many promising developments were introduced and the results of a number of research projects were put into practical use.

In the electroplating field there was a great increase in bright nickel plating, bright copper plating, high-speed copper plating, and electroplating on aluminum. The bright nickel plating process was augmented by a method giving "semi-bright" deposits of good buffing qualities. Since there is a critical shortage of skilled polishers, this characteristic is of significant importance because it decreases polishing and buffing operations. Developments in high-speed nickel plating baths now permit deposition at higher current densities than previously, thus increasing production.

Bright copper plating, which is expected to be of great importance in plating zinc alloy die castings, particularly as an undercoat for either nickel or chromium or both, is now a reality. A method has been introduced which requires little or no change in equipment than for ordinary copper plating. Buffing is entirely eliminated through this type of plating—an important consideration when handling zinc and other soft metal parts. If steel is plated and scratches show through, the copper surface can be buffed without difficulty. It is a simple matter to convert conventional copper plating solutions to bright copper requirement. (For complete details of this process, see the article "A New Process for Bright Copper Plating" in this issue of MATERIALS & METHODS.)

An interesting development reported by the National Bureau of Standards is the deposition of nickel on steel by chemical reduction. Semi-bright, adherent deposits are produced which are comparable to electrodeposits in corrosion resistant properties. The process will be of value in coating jobs, such as the insides of small holes, where electroplating is impractical or extremely difficult.

The techniques developed during the war for nickel plating the interior of steel pipe, were made commercially available. The process can be used on pipe sizes up to 18-in. dia. with coating thicknesses from 0.005- to 0.1-in. Interest also continued in lead coatings on steel which came into such wide use during the war.

A process for the electrodeposition of tungsten alloys, particularly those with iron, cobalt and nickel, was announced. The developments made in fluobrate plating solutions include lead-tin alloy plating and high-speed copper plating.

The electrodeposition of metal on plastics is advancing rapidly. Metallized plastics are being widely employed in electrical and electronics engineering as well as for costume and novelty jewelry.

Application of tin coatings directly to aluminum is now possible using supersonics. Supersonic waves produce vibrations on the aluminum sheet as it is dipped into the molten tin bath. The vibrations remove the oxide layer from the aluminum and replace it with the tin which alloys with the aluminum surface.

The process of continuously coating sheet steel with aluminum by hot dipping, developed just prior to the war, received wide use in civilian production for the first time this year. The actual thickness of aluminum coating is about 0.001-in. on each side. It imparts to the sheet good corrosion and heat resistance, and resistance to oxidation at elevated temperatures up to 900 F.

The use of phosphate coatings as an aid in drawing became standard practice in many plants during the past year. It is being used extensively in

seamless steel tube mills and other deep-drawing operations. A recent development makes it possible to obtain a phosphate coating on aluminum. It is applied by spray or immersion. Where color treatment of phosphate coatings is desired, a method is now available. The colors, which are gray, blue, purple, green and olive drab, result from a chemical reaction when the parts are dipped in the coloring solution.

Blackening, using a cupric oxide coating in place of black nickel plating, has been adopted for many applications. Using a cupric oxide coating results in excellent adhesion of paint to brass.

There have been a number of developments in automatic painting equipment. For the first time equipment is available for handling a variety of parts simultaneously. The designs include the stages of cleaning and chemical surface treatment, applying the paint, and curing the finish.

In polishing and buffing, some of the most important advances were the improvements of liquid polishes and the development of methods for spraying buffing compounds onto the buffing wheel.

The adoption of finish honing, which involves the use of a tumbling barrel for deburring, was widespread. The parts are tumbled in sectional barrels with the proper abrasives; the burrs are removed in a much shorter time than formerly required without changing the finish dimensions.

A new buffing machine has been developed in which the buffing compound is sprayed on the buff. Many advantages are claimed for this method over the former method of using compounds in stick form. The spray unit can be adjusted to provide a continuous or intermittent spray, whichever may be required. When using this machine the operator can use both hands to manipulate the work.

A new polishing method for silver plated objects was perfected. The plated piece is put into a bath of silver cyanide solution just as in the regular plating operation. However, a positive instead of a negative current is applied intermittently. The resulting luster of the plating is comparable to that obtained by hand buffing methods.

Coatings

Many new finishes and coatings—some "brand" new, others developed during the war—were introduced last year. Among these are the new non-oxidizing synthetic enamels which cure at high temperatures (up to 700 F) in a minute or less. Their base is a thermosetting resin with high chemical resistance. Other newly developed finishes are the synthetics, which dry as fast as lacquers. They can act as both priming coat and finish in one or multiple-coat applications. Improved vinyl finishes and modified synthetic rubbers, which are air drying or baked materials with high chemical resistance, have also been developed. Also, 100% solid resin-impregnating compounds were developed for electrical insulation.

A new application of plastic coating is in the production of pipe for corrosive applications, such as those encountered in oil-well drilling. The inside of steel piping is covered with four coatings of an air-drying phenolic resin which withstands temperatures as high as 400 F and which must resist abrasion, embrittlement and flaking. Most of this type pipe now produced is about 4½ in. in dia., but other sizes will become available, as will pipe so coated inside and out.

A new finish which will probably see wide use is a spray coating that gives a hammered-finish appearance in a single application. The finish is smooth but looks rough and hides defects, such as weld marks and scratches, in the base metal.

Black finishes, namely the oxide and chromate-containing oxide finishes, were improved and are now being widely used in the business machines.

In the field of thin-film, removable rust preventive coatings the tendency has been away from grease type materials and toward the solvent type preventives developed during the war. A material development, which will see use not only as a rust preventive but also as a surface protective means during forming operations, is a peelable plastic film, known as Liquid Envelope. It is a film-forming resinous compound carried in a volatile vehicle. It adheres tightly to the surface of metals even during deep-cupping operations, but can be stripped from coated surfaces easily. In its use as a packaging material it can be made to form an envelope on a framework of industrial tape connecting the outermost projections of the part. Some producers of stainless steel are now producing sheet with such a coating. In addition to serving as a protective coating, the plastic acts as a lubricant in drawing operations and in many cases makes unnecessary cleaning operations on stamped parts.

Testing and Inspection

With the ever increasing demand for greater accuracy and higher quality in finished parts, testing and inspection has advanced in recent years to a new level of importance. Small companies, that only seldom scientifically inspected their end products or tested the materials going into them, are now accepting engineering inspection and testing as an integral part of the manufacturing process. In addition, large organizations are not only increasing their testing and inspection facilities, but also are rapidly changing many of their old ideas on the subject. The war production years taught them to apply inspection and testing techniques at critical points along the production line instead of only at the end and thus seek out the trouble at its source.

These trends, particularly evident this year, have stimulated both the development of new testing and inspection devices and the refinement of old ones. The emphasis is on practical, easy-to-operate instruments and equipment which will take inspection and testing out of the laboratory and into the plant wherever possible for routine and production line work.

Put into practical use this year have been the direct reading spectrographs. Heretofore, spectrographic analysis was strictly a laboratory procedure for small volume work and too slow for many production applications. With the direct reading spectrographs, the quantities of a number of the elements present in a material are obtained within

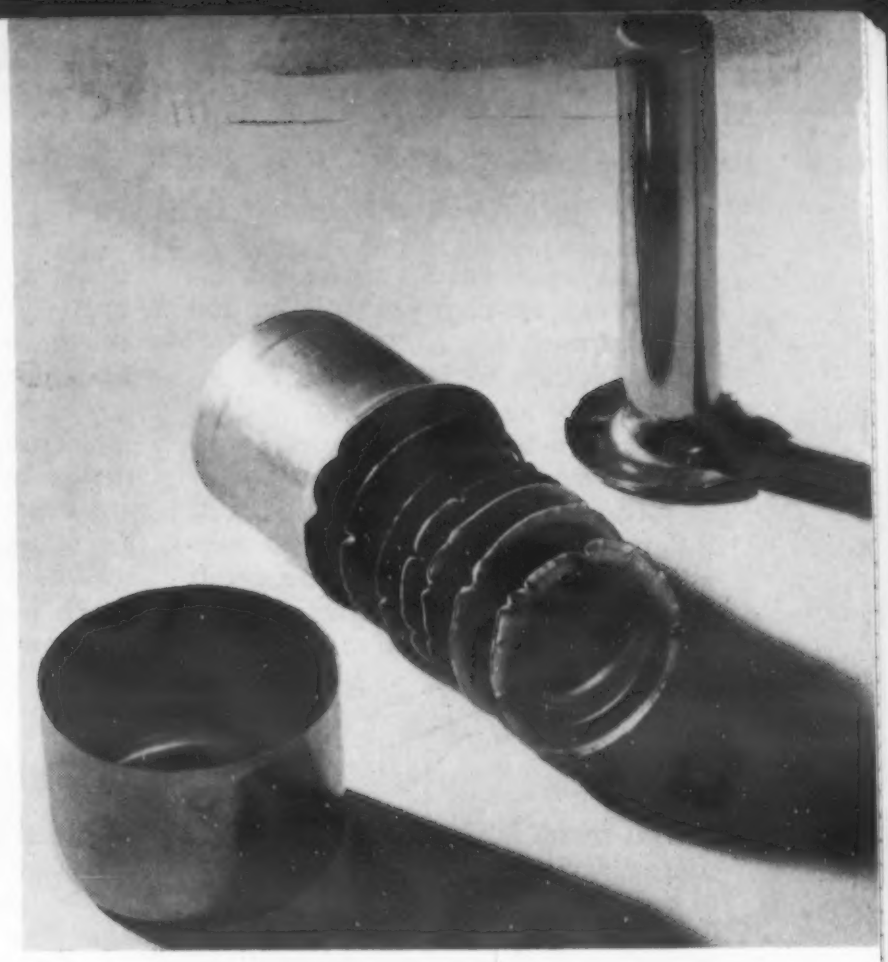
a few minutes by a single operator. This is of particular value to the metal producing industry because now control analyses can be made quickly and the high cost of holding hot metal is largely eliminated. At the Ford Motor Co. a direct reading accessory was developed for the spectrographic control of magnesium foundry heats which will analyze accurately as many as 80 determinations an hour.

New developments have also increased the practicality of X-ray diffraction. By former procedures hours were required to perform a test. With the development of the Geiger-Counter X-ray spectrometer, the time element has been reduced so that information on the structures and physical states of materials can be gained in a matter of minutes. This is accomplished through the use of Geiger-Muller counter tubes and a potentiometer recorder. The counter tubes locate the characteristic beams; the pulses from the counter are conditioned by electronic circuits and fed into a frequency meter circuit arranged to drive a suitable indicating meter whose deflections indicate the locations and intensities of lines as scanned. The recorder makes the unit completely automatic by plotting the values from the counter.

The increased use of high temperature service alloys has necessitated the development of testing techniques at elevated temperatures. For high temperature fatigue testing of materials in tension and compression, a machine of 10,000-lb. capacity has been developed. It applies pulsating loads at a rate of 3,600 c.p.m. to a cylindrical specimen and for specimen temperatures up to 1800 F. Work is under way on the development of other apparatus and techniques for the direct determination of the properties of metals at high temperatures.

A number of refinements in fatigue and simulated service testing machines have been made during the year, such as the Sonntag mechanical oscillator system. A feature of this method is the application of repeated constant loads rather than constant deflections. A small machine was also developed for fatigue testing of metallic or non-metallic sheet materials up to a thickness of 1/8 in.

Another development was General Electric's pneumatic fatigue testing machine for obtaining the fatigue limit of materials vibrating at resonant frequency. This device was originally designed for testing jet engine buckets, and greatly accelerates the fatigue testing. In some cases failures are achieved in ½ hr.



Type 304 stainless steel is drawn into pen caps through a total reduction from blank area diameter of 80.5%. (Photo Courtesy Allegheny Ludlum Steel Corp.)

A new load indicating system for testing machines which has a wide spread of ranges from high to low, down to extremely low ranges, has been designed for use with such materials as films and foils, wires, sheet, fibres, and rubber-like materials. It is a Tate-Emery null method system with a mechanical lever in place of the usual hydraulic coupling. Another device which extends the usefulness of static testing machines is the Tate-Emery Air Cell. With this accessory it is possible to weigh very low loadings on any capacity machine.

In hardness testing there has been a continued trend toward testing intricate shapes on the part actually receiving the wear. For example, many automotive companies now are checking their gears on the pitch line and on the wearing surfaces of cams. The use of hardness testing of plastic materials has also increased, promoted principally by the present ASTM specifications on hardness properties of plastics.

Also developed by General Electric were two low-stress elongation testers that measure stiffness or springiness of large and fine copper wire. These devices show proper—or improper—degree of flexibility for such parts as coils, stretch being indicated on a dial gage.

Several important advances have been made in the field of non-destructive testing and dimensional inspection. In radiography, the design of the 20 million-volt Betatron has passed through most of its growing pains and is now ready for application in the heavy metal industry. It has the optimum in sensitivity and is capable of penetrating 20-in. of steel in approximately 20 min.

Some refinements have been made in fluoroscopy. A mass production fluoroscope employing a photoelectric cell was developed. A photomultiplier tube can be set to be sensitive to any given variation in the intensity of light reaching it. Thus, a sufficient change in light resulting from a faulty product will be picked up by the tube and trip an indicating device.

In the field of thickness gaging, devices having greater speed and versatility were introduced. Electric gages for strip mills have been improved, so that with one new design, gaging of strip going through the mill at 5,000 f.p.s. is possible. A new gaging technique involving the use of X-rays was developed by X-ray Electronic Corp. The instrument is a non-contact gage meter that can check thicknesses of sheet material, even when hot, at any desired rate of speed. An aluminum foil thickness gage has also been designed that will show differences of 0.0001 in. as compared to 0.0004 in. previously possible. The Penetron, for measuring wall thicknesses, although not strictly new this year, was introduced to many peacetime applications. Supersonic inspection devices for de-

tecting internal flaws were refined further to increase their practicability and range of use.

An addition to instruments for inspecting metals by magnetic analysis was the Du Mont Laboratories Ferrograph. Primarily used as a comparator in such applications as sorting parts of different composition or different metallurgical characteristics, the Ferrograph correlates permanent magnetism and metallurgical properties using a low frequency energizing field below 25 c.p.s. Work is in progress on the development of a comparator for metallic nonmagnetic materials.

The use of stress analysis continued to increase as an important source of design information. The SR-4 gages are being widely used. In the use of Stresscoat, a technique was developed to obtain patterns of residual stresses which indicate qualitatively whether they are compression or tension. Progress has been made to use Stresscoat to measure stresses in parts under dynamic conditions.

Finally, the important matter of specifications received some much-needed attention this year. A general review of metal specifications to include war-time developments and to eliminate or revise alternate and emergency specifications is in progress in the Federal Specifications Board and the American Society for Testing Materials.

Instrumentation and Control

The trend in instrumentation and control during the past year continued to be in the direction of complete automatic process control. The equipment is being tailormade to fit the needs of each installation so that entire processes or groups of processes are being completely integrated and automatically controlled.

All of the refinements made in indicating, recording and control instrumentation are too numerous to mention and can only be discussed broadly. Many of the refinements were toward providing more sensitive and accurate instrumentation; other changes improved the construction, convenience and operating characteristics. A pyrometer controller was developed which provides two electronic circuits that operate independently but in harmony with each other. A 25-cycle operation strip chart electronic potentiometer was designed for steel mill use. Other refinements included a front-set mercury switch type control for circular chart electronic potentiometers, back-set mercury type auxiliary switch for both circular and strip chart electronic potentiometers, external chart drive switches, and omission of internal power switches.

Several significant developments in pyrometer design have occurred during recent months. A radiation type surface pyrometer was designed by U. S. Steel Corp. for surface temperatures up to 2400 F. It can be operated by one man. The pyrometer was developed for taking external temperatures of hot steel slabs in the heating furnace before they enter the rolling mills. It can also be used in research of effective furnace designs and locating heat leaks. The instrument is mallet-like in shape; it has a radiation tube lodged inside a cylindrical head. Radiation reaches the tube through a lens. Readings are transmitted by wires through a long handle to a recording potentiometer. The head is 8¾-in. high and is water cooled.

New aluminum processing temperature measuring equipment was announced by Brown Instrument Co. A thermocouple for measuring molten aluminum temperatures, its chief feature is that the assembly is resistant to attack by molten aluminum. It has a silicon carbide protecting tube that is said to be better than cast iron in durability. Also, by its speed of response to temperature changes, closer control of aluminum casting and melting is achieved.

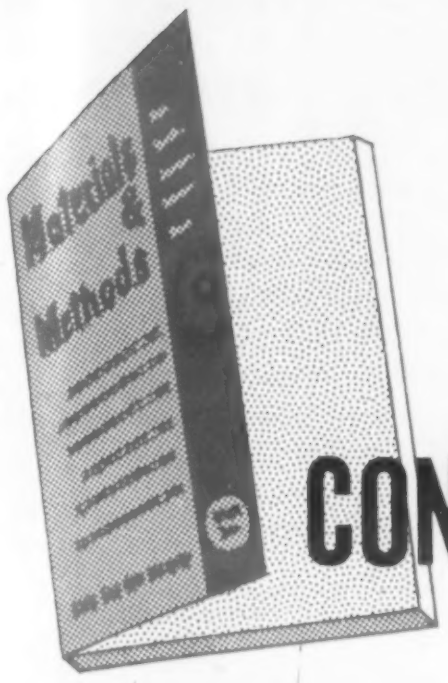
Among the other design improvements is the extension type portable pyrometer of the Wheelco Instruments Co. The design permits the choice of plug-in angle extensions where varying applications require different kinds of thermocouples. There is also the new resistance thermometer bulb of Leeds & Northrup Co., which can be used for temperatures up to 1,000 F in such applications as ovens, tanks and ducts.

The application of continuous dewpoint recorders has contributed directly to the precise control of furnace operation by providing a constant and accurate report of the amount of moisture in a gas atmosphere. One of these instruments, developed by General Electric, is a combination of heater, refrigerator, mirror, and gas chamber. The condensation of moisture on the mirror is observed by a photoelectric eye, and the mirror temperature is recorded on a chart when dew forms. The refrigerator and heater hold the dewpoint temperature within a tolerance of 2 deg. so that a continuous reading of the chart is achieved. The present instrument is for dew points of −50 F. Development is now in progress to enlarge the range to −100 F.

In general, development in welding controls was confined to improvement of existing equipment. A development which found increased use this year was the ampere-squared second recorder for use in resistance welding of corrosion-resistant steel. It provides a means for evaluating the heat and serves to control the welding performance within the right limits of heating and to open the welding power circuit if these limits are not observed by the operator. Additional improvements were made in synchronous tempering controls for resistance welding air-hardenable materials, specifically for the flash welding of high carbon steel wire. If welded in the normal manner these materials tend to become brittle at the welded spot. With synchronous tempering control, the weld can be tempered by applying two pulsations of current, separated by a time interval without removing the electrode from the work. The first pulsation provides the required heat for welding; the second pulsation gives the correct heat for tempering.

The expanding use of vacuum systems in industrial applications is requiring devices such as leak detectors and measuring instruments for efficient operation. A development of last year was an ion gage able to measure or monitor continuously the highest vacuums ordinarily encountered in both industrial applications and laboratory processes. The equipment measures pressures as low as 10-7 mm. of mercury. In operation, a gage tube is sealed to the high-vacuum system and the tube is connected electrically to the control unit.

The leak detectors recently developed are a special application of the mass spectrometer. They use helium gas and can determine the exact location of any leak. The detectors will detect concentrations of helium as low as 1 part in 200,000 parts of air.



CONTENTS NOTED

A monthly department dedicated as a forum for the interchange of ideas between readers and editors. All readers are urged to take advantage of this space and participate in the discussions presented.

Aluminum Power Costs

To the Editor:

In your September article on "Economics of Engineering Materials" we believe you did not convey the idea that power for the producers of aluminum and magnesium is cheap from Bonneville. Power is now being sold from the Bonneville Dam in Oregon at 2 mills per kilowatt-hour for primary power, and for secondary power is available at 1 mill. We hope, therefore, you can get this idea of cheapness of power here before your readers.

J. G. McCallum
Bonneville Power Administration,
U. S. Dept. of the Interior,
Portland, Oregon

True, we had these figures before us when we wrote the article, but did not use them in the article. R. S. Reynolds, of the aluminum company of that name, has stated publicly that he could buy power from Bonneville for 2 mills as against 3⅓ mills from Tennessee Valley Authority. It is assumed that power cost of Alcoa at their own Tennessee dams is only 0.5 mill.—The Editors.

New German Brazing Alloy

To the Editor:

On page 1374 of the November MATERIALS & METHODS is a reference to the German silver-*manganese* brazing alloy that is capable of withstanding higher temperatures than many silver brazing alloys. The only thing is that MATERIALS & METHODS, like two or three other sources of information, refers to the alloy as silver-magnesium instead of silver-manganese. I don't know where the confusion originated; I first saw it in *Science News Letter* for August 31, 1946.

John L. Christie,
Metallurgical Manager
Handy & Harman,
Bridgeport 9, Conn.

Unfortunately, the error referred to by Mr. Christie was originally made in a government report of the product and perpetuated by several magazines including this one.—The Editors.

"No-Carbon" Stainless

To the Editor:

In the May 1946 issue of your excellent publication, MATERIALS & METHODS, the writer's attention has been called to a note with the heading: "No-Carbon" Stainless Steel.

The following comment may seem somewhat post festum due to the fact that the May issue of your journal had, unfortunately, gone astray and only reached us quite recently.

Commenting on this note, I should like to say that I do indeed concur in the view that a stainless steel containing less than 0.03% carbon is "an extremely promising material," but in case your informant has led you to believe that production of the same represents a "new" answer, I should like to inform you that the development of such "No-Carbon" stainless steel dates back quite a few years.

As a matter of fact, the writer's investigations on this subject were started in the year 1922, at which time he realized the importance of producing such low carbon stainless steels.

At that time he carried out a series of tests, partly by making the steels up from especially refined components, partly also by the reduction of mixtures of pure oxides of the alloying elements using very low carbon reduction metals and alloys.

Later on, on various occasions, I followed up the original concept of producing very low carbon and weld-proof stainless steels in order to develop techniques which would allow the production of such materials on any scale at a cost comparable with regular commercial grades.

It was not, however, till the years 1933 to 1938 that the writer had the opportunity of pursuing the matter further by conducting industrial investigations in Norway.

The outcome of these operations resulted in the writer erecting a plant at the Northfield Works of Re-

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fined Stainless Steel Co. at Rotherham, near Sheffield, England, having an ingot capacity of about 2,500 tons per annum as the first steps towards a joint venture with a group of Sheffield steel people.

The before-mentioned plant commenced regular operations only a short time before the outbreak of war, and to begin with upwards of 500 tons of stainless steels containing in the range of 0.02 to 0.03% was produced. The bulk was made into high tensile cold-rolled strips and sheets which went into aeroplanes participating in the famous "Battle of Britain."

The answer of "No-Carbon" to the problem of carbide precipitation in stainless steels can, in the light of the foregoing facts, hardly be called "new;" nor can the production of such materials be called experimental as the fully commercial production of low carbon stainless steels has been proved at the writer's works.

Such materials, made according to various procedures developed by the writer, not only solve for most industrial purposes the incidence of weld-decay but make these remarkable steels, in many respects, into virtually new materials.

In closing, I should only like to add that another particular significance of this process is that it makes possible the conversion of stainless steel scraps into weldproof products of such very low carbon contents.

Sigurd Westberg

Refined Stainless Steel Co., Ltd.,
Rotherham, Yorkshire,
England

We are pleased to have Mr. Westberg's comment in regard to so-called no-carbon stainless steels. It is understood that steel companies in this country are doing further research work along similar lines. We agree, then, in view of the uses already made of the Refined product that such a material is more than just promising.—The Editors.

Conductivity of Cunife

To the Editor:

We saw, with a considerable degree of interest, that in your August 1946 issue (p. 432) you printed a condensation of an article on permanent magnets by Mr. W. E. Ruder of our Research Laboratory.

We are glad to know that you found the material interesting enough to abstract. At the suggestion of Mr. Ruder, however, we would like to take this opportunity to call your attention to one fact, not in criticism, but only in pointing out something that undoubtedly is a typographical error. In speaking of Cunife the article says that "It has an electrical conductivity of 9.2 times that of copper." It should read "9.2% that of copper."

Otherwise, the presentation is an excellent one and the abstracting extremely well done.

J. G. Shaw, Jr.

General Electric Co.
Schenectady, N. Y.

It seems that regardless of the precautions that are taken to avoid them, distorting errors make their appearance from time to time in most technical magazines and books. We apologize for the confusion these errors cause, and can only pledge to redouble our efforts to keep them to a minimum.—The Editors.

Forging Tolerances

To the Editor:

In looking through the September 1946 issue of MATERIALS & METHODS I was happy to see my article on "Drop Forgings for Gas Turbine Applications."

It is regrettable that there is an error in the printing which is of sufficient magnitude to warrant a correction notice. It occurs in the statement on page 645, column 1, dealing with tolerances and should read, "These tolerances (as little as ±0.010 in., –.000 in. on sections ranging from 0.30 in. to 0.020 in. in thickness) — —." The present statement reads, "±.010 in. –0 inch," which is by way of being quite confusing on a subject which allows no room for confusion.

C. I. Schweizer,
Chief Metallurgist
The Steel Improvement & Forge Co.,
Cleveland 14, Ohio

We are sorry that an error which apparently occurred during transcribing appeared, with the possibility of creating some confusion in the minds of readers.—The Editors.

Aluminum Plant Capacity

To the Editor:

I have read your article (Economics of Engineering Materials) in the September, 1946 issue of MATERIALS & METHODS and noted what you have said in the last full paragraph in the first column on page 614. I think your figures are not quite in accord with actual facts. During the war the government controlled, according to the report of the Surplus Property Board, 57.9% of the aluminum production in this country, Alcoa 35.2%, and Reynolds 6.9%. These figures have changed materially in the postwar world. At the present time the aluminum reduction capacity in the United States shows that Aluminum Company of America has 52.5%, Reynolds 30.1%, and Kaiser 17.4%.

Douglas B. Hobbs

Aluminum Company of America,
Pittsburgh 19, Pa.

With the figures on aluminum production fluctuating rapidly during the period of disposal of government controlled plants, we appreciate having an accurate statement of actual conditions.—The Editors.

MATERIALS & METHODS Engineering File Facts

NUMBER 128
January, 1947

MATERIALS: Zinc and Zinc Alloys

Digest of Specifications for Zinc and Zinc Alloys

Slab Zinc (Spelter)

ASTM Specifications		Federal Specifications		Commercial Name	Composition, Per Cent					
Spec. No.	Grade	Spec. No.	Grade		Pb (max.)	Fe (max.)	Cd (max.)	Al	Pb + Fe + Cd (max.)	Zn
B6-37	1a	QQ-Z-351	A-1	Special High Grade	0.007	0.005	0.005	None	0.010	Remainder
	1		A	High Grade	0.07	0.02	0.07	None	0.10	Remainder
	2		B	Intermediate	0.20	0.03	0.50	None	0.50	Remainder
	3		C	Brass Special	0.60	0.03	0.50	None	1.0	Remainder
	4		D	Selected	0.80	0.04	0.75	None	1.25	Remainder
	5		E	Prime Western	1.60	0.08	—	—	—	Remainder

Rolled Zinc

Specification	Typical Compositions, Per Cent[1]						Type	Form
	Pb	Fe (max.)	Cd	Cu	Mg	Zn		
ASTM B69-39	0.05 (max.)	0.010	0.005 (max.)	0.001 (max.)	—	Remainder	I	Coils or sheets cut from strip (ribbon) rolled zinc
	0.05 to 0.12	0.012	0.005 (max.)	0.001 (max.)	—	Remainder	II	Pack rolled zinc
	0.30 to 0.65	0.020	0.20 to 0.35	0.005 (max.)	—	Remainder	III	Zinc plates such as boiler and hull plates produced by any rolling method
	0.05 to 0.12	0.012	0.005 (max.)	0.65 to 1.25	—	Remainder	—	
	0.05 to 0.12	0.015	0.005 (max.)	0.75 to 1.25	0.007 to 0.02	Remainder	—	

Zinc Die Castings

Specifications				Composition, Per Cent							
ASTM	U. S. Army	U.S. Navy	SAE	Cu	Al	Mg	Fe (max.)	Pb (max.)	Cd (max.)	Sn (max.)	Zn
B86-43, Alloy XXI	—	—	921	2.5 to 3.5	3.5 to 4.5	0.002 to 0.10	0.100	0.007	0.005	0.005	Remainder
B86-43, Alloy XXIII	57-93-2A, Class A	46-Z-2, Class A	903	0.10 (max.)	3.5 to 4.3	0.03 to 0.08	0.100	0.007	0.005	0.005	Remainder
B186-42T, Alloy XXXIII	—	—	—	0.10 (max.)	3.75 to 4.25	0.03 to 0.05	0.100	0.007	0.005	0.010[2]	Remainder
B86-43 Alloy XXV	57-93-2A, Class B	46-Z-2, Class B	925	0.75 to 1.25	3.5 to 4.3	0.03 to 0.08	0.100	0.007	0.005	0.005	Remainder
B186-42T, Alloy XXXV	—	—	—	0.75 to 1.25	3.75 to 4.25	0.03 to 0.05	0.100	0.007	0.005	0.010[2]	Remainder

Zinc Base Brazing Solder

ASTM Specifications		Composition, Per Cent			
Spec. No.	Grade	Cu	Pb. (max.)	Fe (max.)	Zn
B64-43	50-50	50.00 to 53.00	0.50	0.10	Remainder
	52-48	52.00 to 55.00	0.50	0.10	Remainder

[1] *These compositions are not a part of ASTM Specification B69-39; they are typical compositions and are listed in the appendix to this specification.*

[2] *Sum of Pb, Cd and Sn (max.).*

[3] *As measured on a ¼ x ¼ in. Charpy Test Bar.*

[4] *Average of 5 specimens.*

[5] *Average of 10 specimens.*

Compiled by Robert S. Burpo, Jr. and based upon data taken from ASTM Standards, Vol. I, 1944; SAE Handbook, 1946 Ed.; and Circular C447, National Bureau of Standards.

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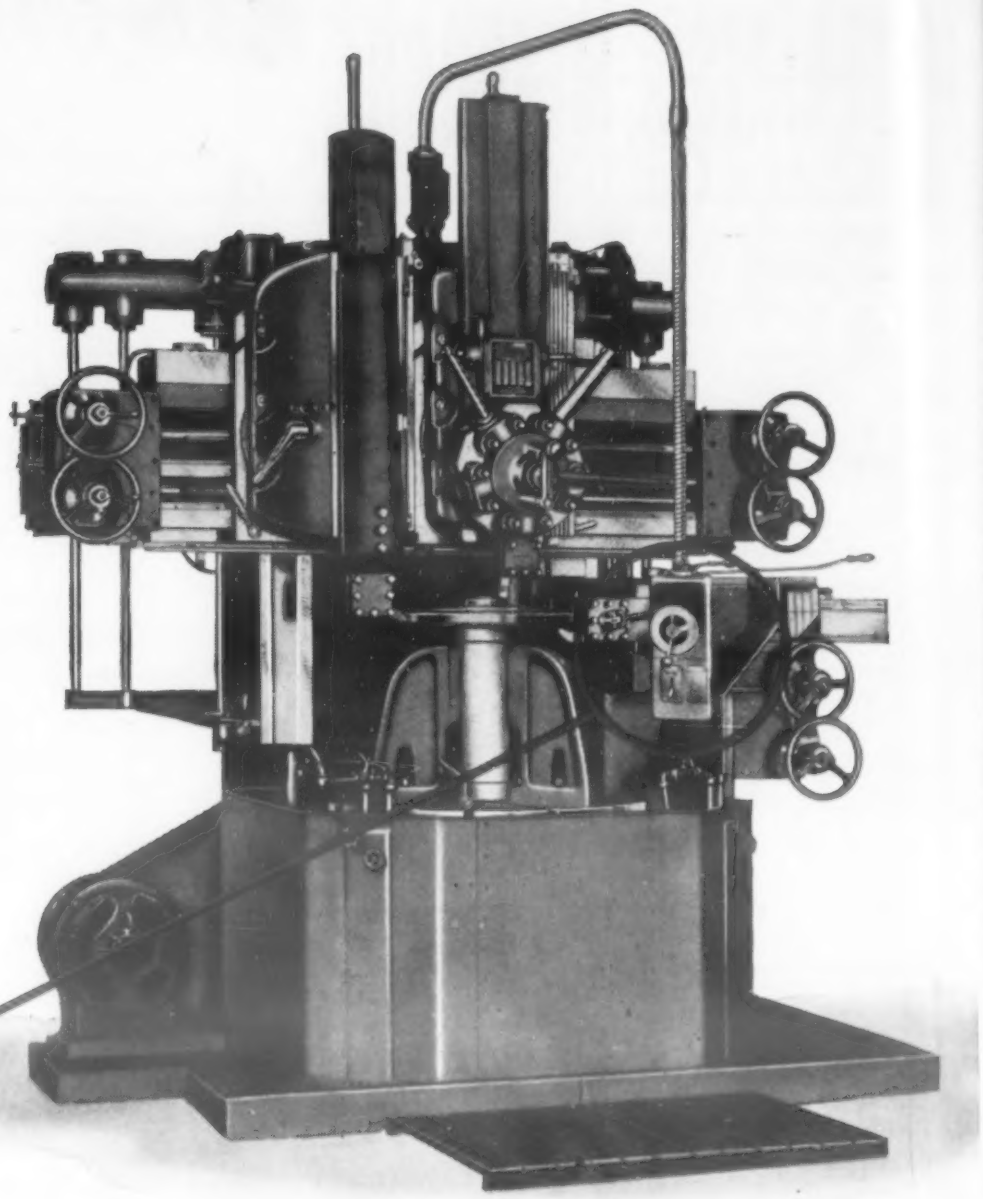

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MATERIALS & METHODS Engineering File Facts

NUMBER 129
January, 1947

METHODS: Heat Treatment of Cast Iron

Changes in Endurance Limit of Alloyed Gray Irons Caused by Heat Treatment

The effects of several heat treatments on the reverse bending endurance limits of alloyed gray cast irons are tabulated in Table 1. Additional pertinent information concerning the composition of the irons and the thermal history and size of the test pieces will be found in Tables 2a and 2b.

Table 1. Effect of Heat Treatment on Endurance Limits

Sample Number (1)	Heat Treatment (2)	BHN	Izod, Ft.-Lb. (3)	End. Limit, Psi. (4)	Ratio, End. Limit to Tensile Strength	Increase in Tensile Strength Due to Heat Treatment, %	Increase in End. Limit Due to Heat Treatment, %
1	A	217	18	17,500	0.35	—	—
2	B	311	16	18,000	0.27	32	3
3	C	248	15	17,500	0.28	25	None
4	D	255	21	22,500	0.32	41	29
5	E	248	18	21,000	0.32	31	20
6	As cast	197	—	16,000	0.34	—	—
7	F	255	—	15,000	0.23	40	–6
8	As cast	207	—	17,000	0.33	—	—
9	G	293	—	15,500	0.20	53	–8
10	As cast	217	—	16,500	0.34	—	—
11	H	277	—	16,500	0.28	—	None
12	As cast	—	—	21,000	0.44	—	—
13	I	—	—	25,000	0.33	59	19

Table 2a. Compositions and Sizes of Test Specimen

Sample Numbers	Size of Test Section, in Inches	Composition, Per Cent								
		Total C	Si	Mn	P	S	Ni	Cr	Mo	Cu
1 to 5	6¾ OD x 3 ID (cored) x 9½ long	2.84	1.40	0.67	0.11	0.06	1.68	0.16	0.46	0.15
6 and 7	8 OD x 3½ ID (cored) x 9½ long	3.06	1.40	0.91	0.11	0.07	1.54	0.30	0.49	—
8 and 9	8 OD x 3½ ID (cored) x 9½ long	3.09	1.74	0.93	0.07	0.05	1.40	0.28	0.58	—
10 and 11	8 OD x 3½ ID (cored) x 9½ long	2.94	1.32	0.99	0.09	0.06	1.39	0.30	0.50	—
12 and 13	7 ID cylinder with 1¼ wall	3.07	1.26	0.90	0.08	0.15	—	—	—	—

(1) See Table 2a for composition and size of test specimen
(2) See Table 2b for detail of heat treatments
(3) Unnotched specimen 0.798 in. dia. and projecting 1⅛-in. above holding jaws were used
(4) Dia. of test piece was 1.000 in.

(Continued on page 121)

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NUMBER 129 (Continued) CHANGES IN THE ENDURANCE LIMIT OF ALLOYED GRAY IRONS

Table 2b. Detail of Heat Treatments

Sample No.	Heat Treatment Code	Detail of Heat Treatment
1	A	Cool casting to room temperature in mold Stress relieve at 1050 F
2	B	Cool casting to room temperature in mold Heat slowly to 1600 F and soak 2 hr. Oil quench Temper at 1050 F for 2 hr.
3	C	Cool casting to room temperature in mold Heat slowly to 1600 F and soak 2 hr. Oil quench to 900 F Hold at 900 F for 16 hr. Air cool
4	D	Cool casting to room temperature in mold Heat slowly to 1600 F and soak 2 hr. Oil quench to 650 F Hold at 650 F for 16 hr. Air cool
5	E	Cool casting to 1600 F in mold Shake out and air cool Stress relieve at 1050 F
6, 8 and 10	As cast	Cool casting to room temperature in mold
7	F	Cool casting to room temperature in mold Heat slowly to 1600 F and soak 2 hr. Oil quench Temper at 1130 F for 2 hr.
9	G	Cool casting to room temperature in mold Heat slowly to 1600 F and soak 2 hr. Oil quench Temper at 1050 F for 2 hr.
11	H	Cool casting to room temperature in mold Heat slowly to 1600 F and soak 10 hr. Oil quench to 900 F Hold at 900 F for 16 hr. Air cool
12	As cast	———
13	I	Preheat slowly to 1000 F Heat slowly to 1600 F Oil quench Temper at 1000 F

Compiled by Robert S. Burpo, Jr. from data presented in a paper entitled "Effect of Heat Treatment on the Endurance Limit of Alloyed Gray Cast Iron," by T. E. Eagan, presented at the Gray Iron Session of the 50th Annual Meeting of the American Foundrymen's Assn., May 1946.

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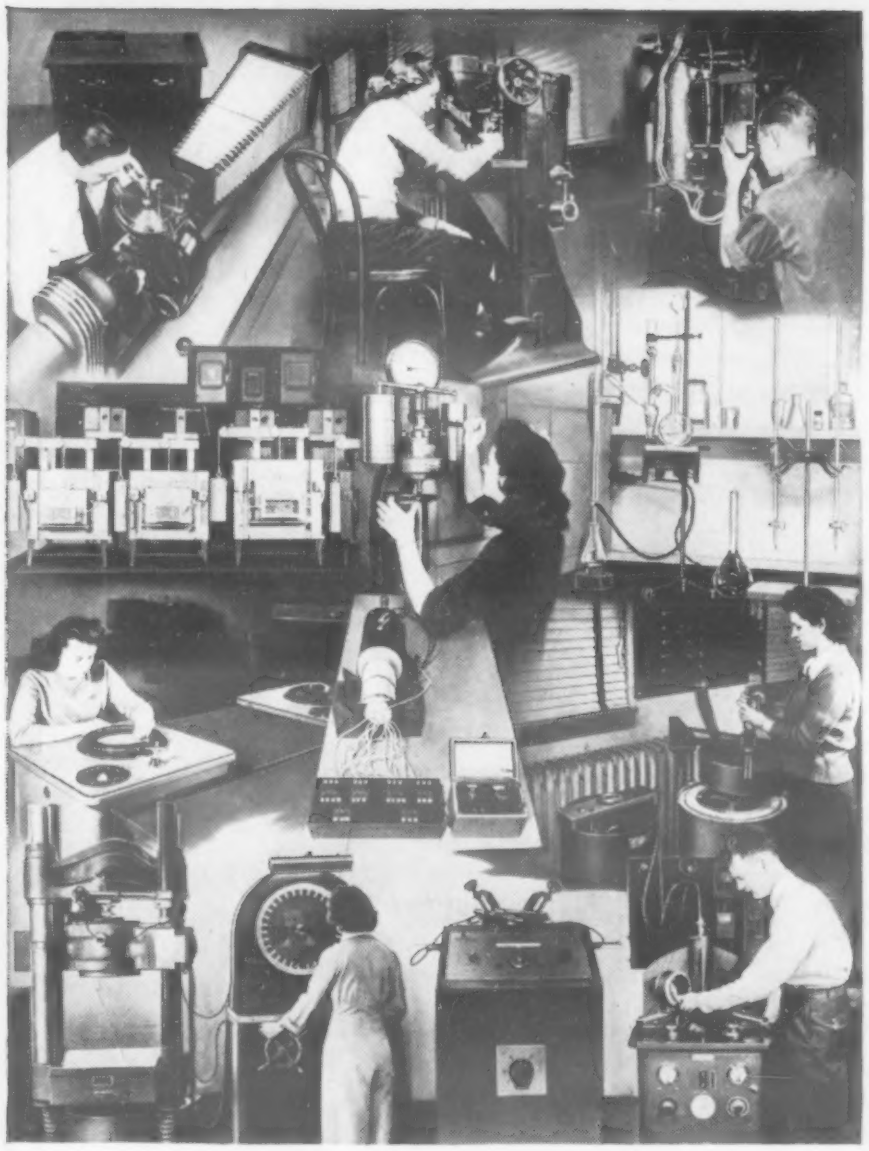

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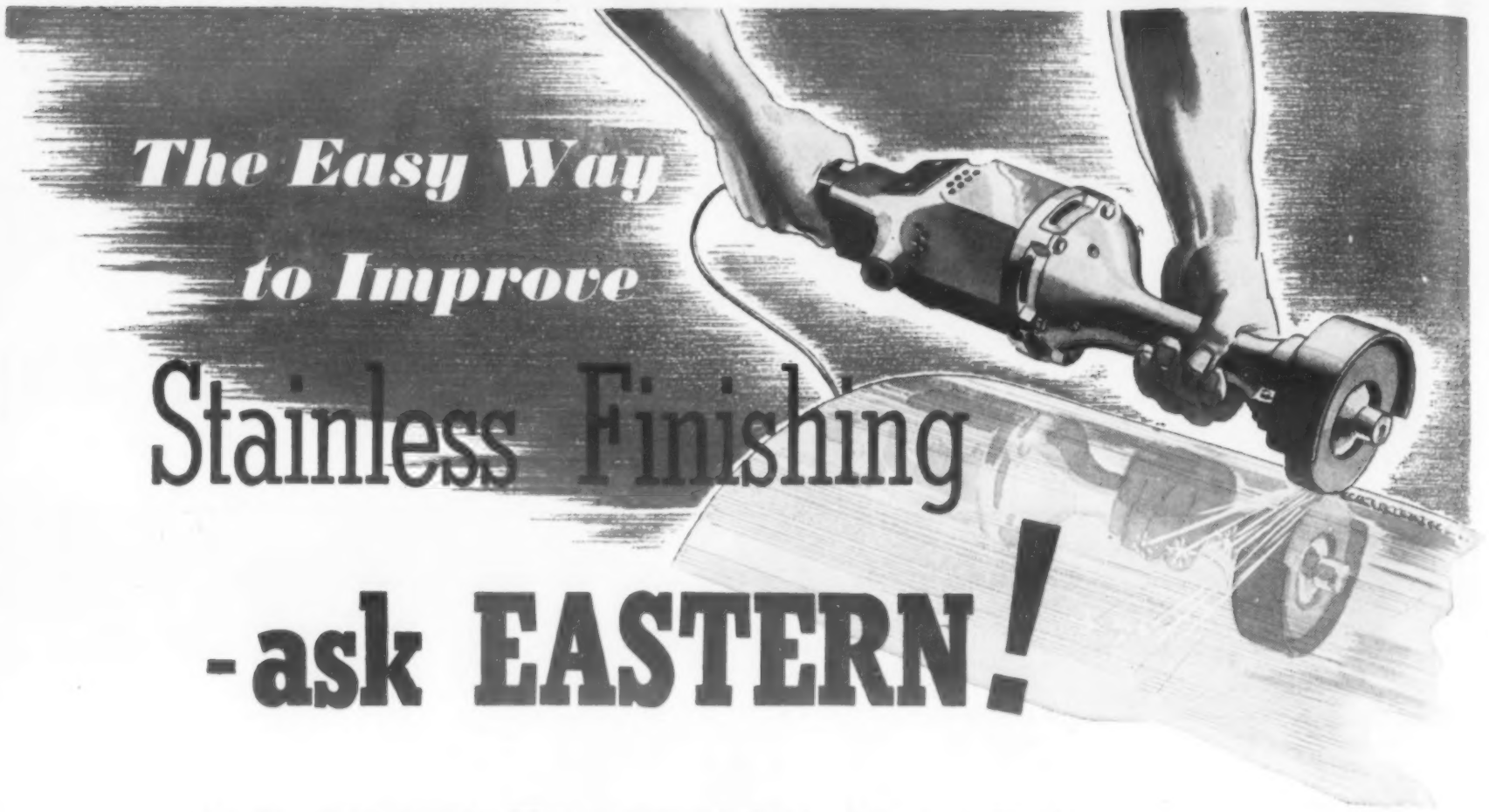
NUMBER 130
January, 1947

Thermal Properties of Metals

Material	Mean Sp. Ht. 60 F to M.P. Btu/Lb. per deg. F	Melting Point deg. F	Heat in Solid at M.P. Btu/Lb.	Latent Heat of Fusion Btu/Lb.	Heat in Liquid at Melting Temp. Btu per Lb.	Average Pouring Temp. deg. F.	Heat in Liquid at Pouring Temp. deg. F
Aluminum	0.248	1215	286.0	169.0	455.0	1380	497.0
Antimony	0.054	1166	59.7	70.0	129.7	1320	138.0
Babbitt-Lead Base	0.039	462	15.8	26.2	42.0	625	48.0
Babbitt-Tin Base	0.071	464	28.6	34.1	67.7	916	91.0
Bismuth	0.033	418	15.1	18.5	33.6	620	37.2
Brass, Muntz Metal	0.105	1630	165.0	69.0	234.0	1850	261.0
Brass, Red	0.104	1952	197.0	86.5	283.5	2250	317.8
Brass, Yellow (85 Cu-15 Zn)	0.104	1877	189.0	84.4	273.4	2150	305.0
Bronze, Aluminum	0.126	1922	235.0	98.6	333.6	2200	368.0
Bronze, Bearing	0.095	1832	168.3	79.9	248.2	2050	272.0
Bronze, Bell Metal	0.100	1634	157.4	76.3	233.7	1900	265.4
Bronze, Gun Metal	0.107	1850	191.5	84.2	275.7	2100	302.0
Bronze, Tobin	0.107	1625	167.5	73.5	241.0	1850	268.9
Cadmium	0.058	610	37.4	19.5	56.9	750	10.0
Chromium	0.157	2929	479.0	—	479.0	—	—
Copper	0.104	1982	200.0	91.0	291.0	2200	24.0
Die Casting, Aluminum Base	0.236	1150	257.3	163.0	420.3	1400	481.0
Die Casting, Lead Base	0.038	600	20.5	17.5	38.0	820	146.0
Die Casting, Tin Base	0.070	450	27.6	30.2	57.8	650	70.0
Die Casting, Zinc Base	0.103	780	74.0	48.0	122.0	980	150.0
German Silver	0.109	1850	194.0	86.2	280.2	2100	311.0
Gold	0.033	1945	62.2	28.5	90.7	2150	97.7
Iron, 60 to 2786 F	0.165	2786	447.0	89.0	536.0	2912	555.0
Iron, 60 to 2560 F	0.158	—	*395.0	3.5	†399.0	—	—
Iron, 60 to 1700 F	0.158	—	*258.0	12.5	†270.5	—	—
Iron, 60 to 1335 F	0.150	—	*187.5	11.5	†199.0	—	—
Lead	0.032	621	18.0	10.0	28.0	720	31.0
Linotype	0.036	486	15.3	21.5	36.8	620	41.6
Magnesium	0.272	1204	311.2	83.7	394.9	1380	441.7
Manganese	0.171	2246	374.0	66.0	440.0	2400	469.0
Molybdenum	0.060	4750	—	—	—	—	—
Monel Metal	0.129	2415	304.0	117.4	421.4	2750	468.0
Nickel, 60 to 2644 F	0.134	2644	346.0	131.5	477.5	2850	505.0
Platinum	0.032	3224	—	48.0	—	—	—
Rhodium	0.060	3570	—	—	—	—	—
Silver	0.063	1762	107.0	46.8	153.8	1950	167.0
Solder, Bismuth	0.040	232	9.3	16.4	25.7	330	29.5
Solder, Plumbers	0.051	414	18.0	23.0	41.0	500	45.0
Steel	0.165	Not given because of the many kinds of steel					
Stereotype	0.036	496	15.5	26.2	41.7	620	46.0
Tin	0.069	450	27.0	25.0	52.0	650	64.0
Tungsten	0.035	6120	—	79.0	—	—	—
Vanadium	0.118	3110	—	—	—	—	—
Zinc	0.107	786	77.8	48.0	125.8	900	142.0
Zirconium	0.066	3090	—	—	—	—	—

* *Heat in solid up to transformation point.* † *Heat in solid after allotropic change.*

Courtesy: Industrial Div., Bryant Heater Co.



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Electropolishing? What cleaning operations are required before stainless steel products can be electropolished? Will electropolishing remove light weld scale and heat discolorations from stainless?

Passivating Necessary? We generally improve the corrosion resistance of finished stainless steel parts by passivating in 30% nitric acid. Would this be necessary if they were electropolished?

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MATERIALS & METHODS

DIGEST

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Edited by H. R. CLAUSER

Aluminum Alloy Condenser Tubes

Condensed from "Corrosion"

Aluminum and many of its alloys have several chemical characteristics which fit them for use in condenser and heat exchanger tubes. They are highly resistant to oxidation and do not form heavy scale when heated in air or in contact with oxidizing substances. Their resistance to sulfur compounds and ammonia is probably the attribute which has resulted in the greatest use of aluminum tubes the past 25 years.

Aluminum is also resistant to certain inorganic chemicals, such as concentrated nitric acid, hydrogen peroxide, boric acid, chromates and, most substantially, neutral salts of the alkali or alkaline earth metals. Cases are known where condenser tubes of 2 S or 3 S have been used continuously for 10 to 15 years without appreciable corrosion. Some waters may cause appreciable localized pitting attack. Hence, such aluminum alloys as 2 S, 3 S, 52 S and 61 S cannot generally be used at plants throughout the country.

An alclad alloy, Alclad 3 S, which is resistant to localized attack, is now being marketed. This has a central core of 3 S with a coating of another aluminum alloy, 72 S, on one or both sides of the 3 S core. The coated surface is bonded metallurgically to the core over the entire surface and is integral with it. The coating is anodic to the core. Thus, if an area of Alclad 3 S sheet is exposed to corrosive water which starts a pit in the sheet surface, once the pit has penetrated the coating, it will not extend deeper into the core. Instead, it will broaden out parallel to the surface. The core will not be attacked until all the coating for a considerable area is removed.

In tests at the Aluminum Research Laboratories, using a highly corrosive water, the time to perforate an Alclad 3 S specimen ranged from 8 to 60 times as long as was required for a similar non-clad 3 S alloy. Over 250,000 Alclad 3 S teakettles have been made and only five of these were reported as perforating in over four years.

American Airlines found that fuel tanks made of 3 S had a service life of about 3000 flying hours, while tanks of Alclad 3 S sheet were still in good condition after 15,000 flying hours. To be conservative, we might assume that 50% of the coating of the alclads would have to be consumed before there would be insufficient coating left to protect the core.

Alclad 3 S tubing can be handled just as if it were ordinary 3 S tubing. In fact, it is generally impossible to distinguish between the two materials by the way they respond to forming, threading, expanding or any ordinary mechanical treatments. It is reasonable to expect that Alclad 3 S condenser tubes will be widely employed in the future.

The cost of the Alclad tubing per linear foot is about the same as that of seamless steel for tubes of smaller diameter, but is slightly higher for larger or heavier tubes. Aluminum alloy tubes have been used successfully in contact with cast iron or steel tube sheets, headers or shells. (R. B. Mears. *Corrosion,* Vol. 2, Sept. 1946, pp. 165-173.)

Mass Production of Tank Wheels in "Black Heart" Malleable

Condensed from "Foundry Trade Journal"

The layout and operation of a plant specifically laid out to produce large quantities of a particular casting in high-grade black heart malleable iron is discussed.

It was decided at the outset to use a naturally bonded sand in the system, largely because of the high hot strength of synthetic mixtures and the danger of hot tears with the low-carbon iron used. A sand of medium grain size with a high clay content was found to be most suitable, and 5% additions of this sand, together with 5% coal dust, maintains a workable mixture. Average physical properties of the mixture are: moisture, 6.5 to 7.5%; permeability 35 to 40 AFA; and green compression, up to 60 psi. Moisture content may be considered high, but moisture tests taken at the hopper mouth above the molding machines show a decrease of up to 1%.

A pouring basin of a special design was used. Jolting and ramming of the mold is controlled to give an average mold-face hardness figure of around 80 to 85 AFA. This ensures a casting free from local swelling and of consistent weight.

The correct adjustment and maintenance of molding machines is essential for speedy and accurate production, and it would appear that the machines used are susceptible to variation in two main particulars. First, a dead flat jolt is necessary, and second, a smooth, level draw. Unless a perfectly level jolt is obtained, ramming is incorrect, and considerable trouble was experienced. It is important, too, that the pattern table be maintained in a truly horizontal position when rolled over, since a perfect draw is not obtained if any degree of error is present.

Air furnaces are used for melting, fired by pulverized coal from an independent high-speed "Attritor" unit. The life of this furnace is usually 12 heats, after which wall repairs are necessary and a new bottom required. Standard capacity for the charge of metal is 18 tons, the slagging sills being raised or lowered to accommodate a minimum of 15 tons or a maximum of 22 tons. Total metal requirements are three heats per day.

When a furnace is tapped, every effort is made to maintain a continuous stream without bolting up, and to empty as quickly as possible. In order to do this, a hand-ladle is used to catch the stream between bogies, metal caught in the ladle being poured back into the bogie standing under the stream.

Unavoidable splashing occurs while changing bogies. However, the operators soon become adept at changing bogies, not more than 4 to 5 sec. being necessary for the changeover. A flow of metal at the rate

of 1 ton in 3 min. is an average stream. General layout, annealing ovens, coring of mold, etc. are also discussed. (A. B. Bill & J. Peters. *Foundry Trade J.*, Vol. 79, May 23, 1946, pp. 75-81, May 30, 1946, pp. 113-116.)

Sandwich Laminates

Condensed from "Modern Plastics"

For lightly loaded panels, where stiffness and weight determine design, the honeycomb sandwich is the most efficient structure yet developed. The honeycomb core is made of a resin-impregnated sheet material which has been cured and assembled into the form of nested hexagonal-shaped cells resembling bees' honeycomb.

While any number of different types of fabrics, papers, or fibrous combinations may be used, low-cost cotton sheeting or paper impregnated with a phenolic-type resin has been found most satisfactory. A core with a cell size of 3/8 to 7/16 in. across the flats is satisfactory and economical for nearly all applications.

A wide variety of materials may be used as facings, depending upon properties desired. It is important that the same material, or materials with approximately equal coefficients of thermal expansion, be placed on both sides of the core to maintain a balanced construction.

The bond between core and faces is the key to good honeycomb structures. A satisfactory adhesive for such assemblies must be able to withstand sustained high stress at elevated temperatures with little permanent creep; must have good toughness characteristics as shown in a strip test; must not fatigue or deteriorate under service conditions; and should not have critical curing and handling characteristics. Tests have been developed to determine most of these properties.

"Plycozite," a thermosetting adhesive used in bonding metal faces to honeycomb core, meets the above conditions and has also high and consistent shear strength and good tensile strength. Tests showed that its toughness factor is 24 or higher; it had a relatively small amount of creep during the first 23 hr., with no increase in the next 42 hr.; and its ultimate shear stress was better than 9000 psi. at room temperature, and a minimum of 6000 psi. at 150 F.

Results of accelerated weathering tests of metal-faced-honeycomb-core specimens bonded with "Plycozite" without edge banding indicated that this type of construction stands up well under weathering. Tests of similar panels immersed in water for three and for seven days indicated the ability of the core and the adhesive to withstand such extremely severe conditions. Flexural fatigue tests indicate a fatigue limit of about 70 psi. shear stress in the core.

Honeycomb-core structures are classified as plates and can generally be handled with existing theories of plates. There are other considerations that are not critical in solid homogeneous plates. In a loaded sandwich structure the core should hold the faces apart by resisting loads normal to the plane of the plate; must act as the shear-carrying element between the two faces; and should stabilize thin faces against local buckling at low stresses. The honeycomb core carries no load in the plane of the plate nor does it add anything to the flexural stiffness of the panel.

In the fabrication of individual panels into finished products, it is necessary to reinforce the core locally and to improve the bearing area of the sandwich at points where structural attachments are to be made.

Several methods are available for making the honeycomb core. The most natural application for these panels is in aircraft. They are being used also in industrial and house trailers and railroad passenger cars. Suggested uses are shipping containers, scaffolding, furniture, partitions, and trays for handling work. (O. S. Tuttle & W. B. Kennedy. *Mod. Plastics,* Vol. 24, Sept. 1946, pp. 129-135, 194, 196.)

Stretch-Flanging Aluminum Alloys

Condensed from "Transactions of the American Society of Mechanical Engineers"

Many aircraft parts consisting of a flat web and a concave flange are produced by rubber-die-forming on a hydropress. The forming action consists of bending the flange around the die radius and stretching the outer fiber of the flange from its original length to that which is achieved when it contacts the die.

Tests were planned to determine the stretch-flanging limits of a number of aluminum-alloy sheet materials at forming temperatures of 70, 300, 400, and 450 F. The maximum temperature of 450 F was selected because of rapid deterioration of the rubber pad at higher temperatures and possible detrimental changes in physical properties of some of the precipitation-hardened alloys.

The general survey of the effect of temperature on the stretch-flange formability was carried out on a 4-in.-contour-dia. die with blanks having 360-deg. flange sectors. Spot tests were made on other variables, such as other contour diameters, sheet thicknesses and sector lengths, in order to observe the major trends introduced by these variables.

The standard aluminum sheet materials that were investigated included 3S-O, 52S-O, 24S-O, 61S-O, 75S-O, 24S-T, 24S-T86, 61S-T, R301-T, and 75S-T covering thicknesses from 0.020 in. to 0.081 in.

The forming of stretch flanges is limited by several forming defects and failures. Among the types of fractures are: stretch rupture, bulging rupture, bend cracks, incomplete forming, and canning. Increased stretch-flange formability is achieved at temperatures above 300 F for all alloys investigated. Each alloy, however, exhibits its own peculiar maximum per cent stretch-temperature curve.

Several types of failures and defects were encountered, the most important being a radially directed fracture initiated at the outer fiber of the flange. When this fracture occurs without necking, the maximum per cent stretch that may be produced approximates the per cent local ductility in the tension test. If, however, fracture is preceded by necking, the permissible per cent stretch is intermediate between the uniform and local per cent strain in tension. Increasing the forming temperature permits greater per cent stretches for some of the more-ductile alloys. (E. G. Thomsen, D. M. Cunningham & J. E. Dorn. *Trans. Am. Soc. Mech. Engrs.*, Vol. 68, Aug. 1946, pp. 643-646.)

Creep Testing Unit

Condensed from "Metallurgia"

A relatively inexpensive, small creep testing machine was developed to make preliminary surveys of high temperature properties on experimental alloys with the least possible expenditure of money and material. More elaborate creep tests on large units are carried out only on alloys which have passed the initial experimental stage.

The test piece has a gage length of 1 in. and a dia. of 0.1785 in. The load is applied through a ten to one lever. The furnace is a stainless steel tube with a Nichrome winding. Temperatures up to 1650 F can be obtained.

At first no attempt was made to use an extensometer measuring directly on the specimen. A hardened steel ball was mounted on the lever arm in the knife edge line so that its movement was exactly five times that of the shackles. A dial gage calibrated so one division corresponded to a strain of 0.01% was mounted above this ball. More sensitive strain measurements were found usually to be not significant in view of the effect of furnace and room temperature variations.

It is desirable to control the test piece temperature within ± 1.8 F. An energy regulator is simple but is subject to occasional instability, causing temperature changes of several degrees. A resistance thermometer controller gives temperature variations of about ± 1.4 F. An electronic method in use on a batch of these units has a thermocouple, potentiometer, galvanometer, photo-cell and gas filled relay. It gives control of about ± 0.45 F, which is much closer than normally required.

Most of the units use a simple instrument giving regulation to about ± 1.4 F. The expansion of the furnace tube relative to an external structure of special low expansion alloys is arranged to operate a micro-switch in the furnace circuit.

Comparison tests between these small units and conventional large units showed good agreement even in comparatively early stages. The small units are satisfactory for the measurement over 48-hr. periods of creep rates down to 0.0005% per hr. and over longer periods down to 0.0002% per hr.

Later developments include an automatic

strain-time recorder and an extensometer attached to the specimen for more refined measurements. The dial of this extensometer is calibrated so one division corresponds to a strain of 0.005%. For higher sensitivity, the dial gage can be replaced by a rhomb carrying a mirror. (G. T. Harris. *Metallurgia,* Vol. 34, July 1946, pp. 129-132.)

Standard Test Bars for the Nonferrous Foundry

Condensed from "Foundry Trade Journal"

In 1931 a meeting of the International Association for Testing Materials was held at Zurich, when it was evident that separately cast test pieces were preferred by the great majority of those present.

While a separately cast test bar can never be designed to assess the quality of a casting, it can fulfill a useful purpose by indicating the quality of the metal from which it is cast, and the degree of control exercised in the foundry.

Different designs of test bars were tested and discussed. As a result of these tests, it has been recommended to the British Standards Institution that the keel bar should be tentatively adopted as a standard for copper-base alloy castings. In the final design, a slight modification was thought desirable, namely, that the bar should be made round instead of having a square section. This will facilitate machining operations and provide a more rapid rate of cooling which is, no doubt, desirable when this bar is used for phosphor bronze and certain types of gunmetals.

It is appreciated that in odd cases some initial difficulty may be experienced in meeting existing specification requirements for metal of 88:10:2 and 86:7:5:2 and for phosphor bronze, when using the keel test bar. There is every reason to believe, however, that the form of keel bar recommended will ultimately prove satisfactory for all copper-base alloys when foundrymen become more familiar with its use, and for the purpose of standardization, the adoption of one design of test bar is a distinct advantage. (F. Hudson. *Foundry Trade J.,* Vol. 79, June 20, 1946, pp. 185-191.)

Anglo-American Magnesium Production

Condensed from "Bulletin of the Institution of Mining and Metallurgy"

A broad outline of metallurgical achievements in England and America in the production of magnesium is presented. More than half of the magnesium produced in England and America during World War II was consumed in the form of incendiaries. American production of magnesium in 1939 was 3,000 long tons, while at the conclusion of hostilities in 1945, proved magnesium production capacity for the United States was 268,000 long tons/annum, and for Great Britain 28,000 long tons/annum.

Physical characteristics gathered from numerous sources and in some cases, where authorities differ by small amounts, mean results are recorded:

Crystalline system	Hexagonal
Atomic weight	24.32
Isotopes	3(24, 25, 26)
Atomic number	12.
Density @ 20 C—99.9% magnesium	1.738 gm./cu./cm.
Density @ Melting point, solid	1.666 gm./cu./cm.
Density @ Melting point, liquid	1.584 gm./cu./cm.
Electrical Resistance @ 20 C	
Cast	4.36-4.49 x 10^{-6} ohms/cu./cm.
Extruded	4.43-4.60 x 10^{-6} ohms/cu./cm.
Rolled	4.50-4.77 x 10 ohms/cu./cm.
Thermal conductivity @ 20 C	0.395 cal./cu./cm./sec.
Thermal conductivity @ 300 C	0.339 cal./cu./cm./sec.
Melting point	649 to 651 C
Boiling point at atmospheric pressure	1,094 to 1,120 C
Latent heat of fusion	46.5 cal. per gm.
Specific heat at 20 C	0.241
Specific heat at 100 C	0.252
Specific heat at 300 C	0.273
Coefficient of expansion	
@ 0 to 100 C	25.5 x 10^{-6} per deg. C
@ 0 to 200 C	26.2 x 10^{-6} per deg. C
@ 0 to 300 C	27.0 x 10^{-6} per deg. C
Young's Modulus	6.4 x 10^6 lb./sq. in.
Shear	2.5 x 10^6
Poisson's ratio	0.33
Potential in relation to the Calomel electrode in seawater	1,400 to 1,500 millivolts

Magnesium production was affected by processes operating on (a) electrolytic reduction, and (b) thermal reduction. The former can be divided into two classes: *i.e.,* one in which the cell was mainly fed with anhydrous magnesium chloride, and the other whose feed was largely composed of a somewhat hydrated salt.

The thermal methods were represented by the following subheads, in which the outstanding characteristic was the use of a particular reducing agent: (a) calcium carbide, (b) aluminum, (c) ferro-silicon, and (d) carbon. The raw materials for thermal processes include: magnesite, dolomite, seawater and natural brine.

Analysis of a typical magnesium of the electrolytic method shows:

Aluminum	0.003%
Manganese	0.04%
Calcium	nil
Zinc	nil
Iron	0.03%
Silicon	0.005%
Copper	0.003%
Lead, Nickel	nil
Cobalt, Silver	nil
Sodium	nil
Boron	less than 0.0001%
Cadmium	0.00001 to 0.00004%
Magnesium	remainder

Each of the thermal processes are reviewed.

While the calcium carbide process has limitations, one plant employing it was delivering regularly more than its designed output. The demand for aluminum powder for alternative purposes curtailed magnesium production by the aluminum reduction method.

The ferro-silicon method yielded the metal of highest purity. Calcined dolomite was reduced by a ferro-silicon containing 75 to 77% silicon in the presence of a small quantity of high grade fluorspar. Condensed magnesium known as the "crown" was of a higher purity than that made by any other full-scale plant with the following analysis:

	Per Cent
Aluminum	0.005
Manganese	0.002
Calcium	0.01 to 0.1
Zinc	absent
Iron	0.002
Silicon	0.004
Copper	0.001
Lead	0.004
Nickel	none
Silver	none
Sodium	<0.0005
Magnesium	remainder

In one plant employing the ferro-silicon process, distorted retorts were blown out *in situ* in the furnace. When this treatment was required, a cap was secured to the retort which was connected to a pneumatic supply at 100 psi. This treatment, skillfully applied, resulted in enormous saving of man-hours and eliminated the need of any hydraulic presses.

The carbo-thermic process has produced a metal of higher purity than is generally given by the electrolytic process, but it can be doubted whether it is yet on an economic basis.

An appendix shows chemical composition and mechanical properties of British and American magnesium alloys. (P. L. Teed. *Bull. Inst. Mining & Metallurgy,* No. 479, July 1946, 25 pp.)

Resin Fibers

Condensed from "Plastics"

One of the important types of plastics materials results from a combination of the techniques of pulp molding and resin impregnation. Although each technique in itself is not new, the combination yields a material, variously called resin fibers, pulp-resin preforms, or simply pulp resins, which can be used for the production of large, high-strength articles containing thin sections and undercuts. Resin fiber articles are resistant to wear, mild acids, and alkalies, and have the durability, smoothness, and finish of molded plastics.

The use of pulp-resin preforms for small moldings is not too promising. With an increase in the size of the molded piece, the choice of a pulp-resin becomes far more attractive, and several of these applications are at present being exploited. Typical examples of this class are plates and serving trays, alarm clock cases, equipment bases, telephone stands, and business machine housings. The important factor to consider in applications of this type is that the cost requirements will govern the choice of materials and that there is strong competition with regular thermosetting molding compounds.

Since the pulp-resin preform is essentially

a two-phase system, its properties will be a function of both the base resin and the fiber. At present, tests are being run on various types of fibers including unbleached kraft, unbleached sulfite, alpha, defibered rag, ground wood, and waste paper, with the object of determining the effects of pulp types and fiber sizes on the finished plastics. Recent findings have indicated that strength properties are not dependent on fiber length or pulp-sheet strength and that mechanical and semi-chemical pulps are suitable for pulp plastics, although in general, these plastics are inferior to those based on chemical pulps.

The results of a series of studies on fiber types in which unbleached kraft, unbleached sulfite, alpha pulp, defibered rag, ground wood and waste paper were tested, have indicated kraft fiber to be slightly better in strength properties than sulfite, rag or alpha pulp, with ground wood or waste paper being quite inferior. There are, however, some contradictory results that have to be clarified in further tests, on the dependency of physical properties on fiber length. From a processing standpoint, there is an optimum fiber length which would be long enough to give good felting properties and not too long to produce a bulky preform.

The short fibers of ground wood or waste paper cause processing difficulties insofar as they tend to plug. Studies on resin types used in conjunction with kraft pulp have led to some interesting conclusions. It has been found that where the resins penetrate into as well as coat the fiber, the result is greater dimensional stability, lower water absorption, and lower impact strength.

Thus, a highly polar water solution or phenolic resin will penetrate into the fiber centers resulting in a more dimensionally stable product than can be obtained with a less polar alcohol solution. On the other hand, the alcohol soluble phenolic will yield a higher impact strength because of the ability of the unimpregnated fiber centers to act as energy absorbers for an impact blow. (H. H. Atlas & R. S. Aries. *Plastics*, Vol. 5, Sept. 1946, pp. 38-40-41, 61-62.)

Hard Chromium

Condensed from "Mecanique"

Although electrolytic chromium deposits were first proposed in 1848, the use of chromium plating to prevent nickel from tarnishing was not developed until about 1922. About 1928 a process was found for depositing chromium layers sufficiently thick and adherent to make possible their use for mechanical rather than ornamental purposes.

Hard chromium layers for mechanical purposes are deposited from a bath containing 150 to 300 g. per 1. chromic acid with 1 to 2% anions, such as sulfuric acid. The bath temperature may vary from 105 to 140 F. However, under any specific set of conditions, the temperature should be held to a variation of ± 4 F for constant results. The anode is antimonial lead while the article being plated is the cathode. The article should be perfectly degreased and washed before plating. All steels, except those with over 5 to 6% manganese, may be chromium plated.

Chromium plates so deposited have a hardness of 700 to 1050 Vickers as well as a remarkable resistance to abrasion and a low coefficient of friction. The impact resistance is low, especially when the layer of chromium is relatively thick and is not well supported. The low impact resistance may be accentuated in some cases by hydrogen embrittlement, which can be overcome by holding for one to two hr. at about 400 F.

Hard chromium plating is used to build up local spots of articles that have worn excessively. It is recommended that the chromium layer be no thicker than 0.012 to 0.016 in. If a thicker layer is required, the part should first be nickel plated almost to the desired size and then a final layer of chromium deposited. The chromium can be easily ground if sufficient care is used.

Chromium plating can also be applied to give the desired wear resistance or coefficient of friction to parts of otherwise satisfactory properties. Chromium plating is sometimes used for resistance against corrosion, as in the case of exhaust valves of combustion engines operating with ethyl fuel. (D. Chambaud. *Mecanique*, No. 335, July 1946, pp. 175-177.)

Ellipsoid Melting Furnace

Condensed from "Metallurgia"

Of the non-crucible furnaces, the horizontal rolling furnace, where the flames from the burner are admitted direct into the melting chamber, is the best known. A modification of this type called the Ellipsoid furnace has been in use on the continent in recent years.

Instead of being mounted horizontally, this furnace is permanently tilted at an angle of 30 deg. from the horizontal. One support is mounted in a ball bearing, while the other is a ring which can be actuated by an electric motor so a rocking motion can be imparted to the furnace. During operation, the rocking motion causes the molten metal to wash constantly over the incandescent lining. The motor which serves for rocking the furnace also effects the pour.

Oil firing is usually adopted, although gas firing is equally suitable. The furnace lining is either of special shape firebricks or stamped. The latter method is generally recommended as being cheaper and having a longer working life equal to about 125 to 130 tons output before relining is required.

Typical performance details are given for five heats. The figures for one of these examples are: metal—red brass grinding swarf; heating-up time—80 min.; oil consumption—12.5 gal.; weight of charge—552 lb.; melting time—30 min.; oil consumption—10%; pouring time—10 min.; oil consumption for pouring—2.1 gal.; metal poured—426 lb.; melting loss—22.9%. (A. J. G. Smith. *Metallurgia*, Vol. 34, July 1946, pp. 153-154.)

Microhardness Testing

Condensed from "Metal Industry"

Microhardness testers may be based on the scratch method, or on the method of static indentation. In a scratch test the cutting instrument, usually a diamond point, is drawn with a constant pressure across the surface of the specimen, instead of being pressed at right angles against it. In the method of static indentation the indenter—in microtesting, usually a diamond pyramid with a vertex angle of 136 deg.—is pressed under a known load and for a certain time into the material, at right angles to the surface of the specimen.

The scratch test is normally used only for qualitative measurements. When a hardness number based on an absolute scale is required, the static indentation method is nearly always employed. If a Vickers diamond is used as an indenter, the hardness number is obtained in the usual way by measuring the diagonals of the impression.

In most types of micro-hardness testers the indenter is either itself loaded or combined with some device for measuring the load. The apparatus described has a simple and practical construction obtained by making the specimen to be examined movable, and by directly applying the load for making the impression or scratch. The load can be varied at will between c:a 1 g and c:a 200 g; the apparatus has a high precision of aim and can be used for both scratch and indentation tests.

The indentation load is measured with considerable accuracy, even at low values, since the apparatus is very simple and the load applied directly by weights.

An ordinary Vickers diamond may be used as an indenter for indentation tests with this new apparatus. If necessary, this diamond can be used alternatively for microhardness tests and for ordinary macro tests. A diamond point is used for scratch tests. For this purpose the Vickers diamond is very useful, or, of course, a pointed diamond cone. A suitably mounted diamond sliver can also be used. In scratch testing it is sometimes possible to obtain valuable information about hardness variations in the microstructure if a pointed cone of hard metal or a pointed hardened steel needle is inserted as a scratch cutter.

Some applications of microtesting are to determine the hardness of aluminum foils and of surface layers of silver, nickel, chromium, zinc, cadmium, etc.; to determine the hardness of thin foils and thin surfaces such as electrodeposited layers directly; to study in detail the alterations in hardness caused by changes in temperature in welding; and to determine the hardness number of components in minerals. (E. Börje Bergsman. *Metal Ind.*, Vol. 69, Aug. 9, 1946, pp. 109-112.)

engineering SHOP NOTES

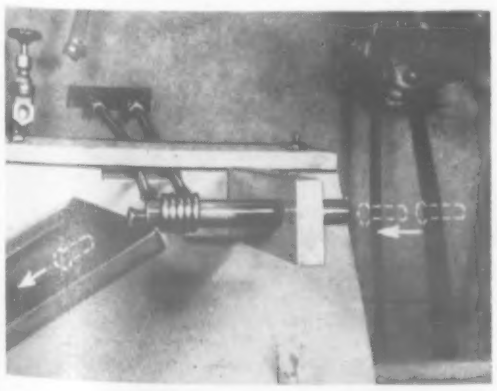
Selective Hardening—Methods and Techniques

by Arne E. Uitti

There are many instances where a large volume selective hardening job can be readily and efficiently handled by induction hardening.

One typical application of induction heating is for selective hardening rivets. These rivets of NE-8742 steel are used in assembling socket heads to swivel wrench handles, and hardening must be carefully controlled. Opposite ends of each rivet must be soft for about ¼ in. The mid-portion calls for a hardness of 48 to 52 Rockwell "C". The special fixture consists of a clear fused quartz tube which is mounted to pass through the center of an induction coil. The length of the quartz tube and the exact placement of the coil are determined by the length of the rivet, and the portion desired to be hard.

Rivets are placed in the tube from the right end. After the fourth rivet has been placed in the tube, the first rivet has slid to the section of the tube surrounded by the induction coil. In this position the rivet is ready for heating. As the coil surrounds only the middle section of the rivet, only that section will be heated. The operator uses a foot switch to start the operation and an adjusted timer cuts the current off at the end of the heating cycle—2½ sec.



Heat rivet ready to drop from quartz tube. Rivet will slide down chute to quenching medium.

After the rivet has been heated, a new one is pushed into the tube from the right hand end. This, of course, pushes the heated rivet from the other end of the tube, and it slides down the chute to the quenching medium—in this case oil.

Another interesting application of induction heating is treating springs used in pinball machines. They are made of pre-tempered spring steel. For mounting purposes each end of the spring must be bent at quite an angle. In order to prevent breakage, it is therefore necessary to anneal each end for about ⅝ in., while at the same time retaining hardness in the center of the part.

The first quantities were run through a lead bath using fixtures; however, the difficulty of loading and holding in the fixtures was not conducive to high production and quality work. Therefore, a set-up using induction heating was devised. The operator loads the springs on the specially designed wheel. Holes in the springs fit over pegs extending from the surface of the wheel.

The wheel is moved slowly by a variable speed drive motor. As the two ends of each spring pass through the field of an induction block, they are heated to an annealing temperature of 1300 F. As the wheel continues to revolve, it passes an unloading trigger which flips the spring into a tote box.

This arrangement permitted the annealing of 2600 pieces per hr. as against 300 pieces per hr. with the lead bath set-up.

—From "Heat Treating Hints," published by Lindberg Engineering Co.

Heat treatment of closed-end quartz tubes more than doubles their life for use in measuring the temperature of molten metal in induction furnaces, reports P. R. Kosting and T. K. Zagwyn, Watertown Arsenal. The quartz tubes were preheated slowly to about 2600 F and held at that temperature for about 20 min. before being immersed for the first time into molten metal in the furnaces. Between succeeding immersions, the tubes were kept at a temperature of 1600 to 1800 F. Tubes treated in this manner were able to withstand an average of 14 successive immersions into molten metal, as compared with the previous average of 6 immersions per tube. The number of tubes lost because of softening of the side walls was reduced from 50 to 10%. Heat treatment at temperatures as high as 2750 F was found suitable. Temperatures at 2400 F and lower proved to be inadequate.

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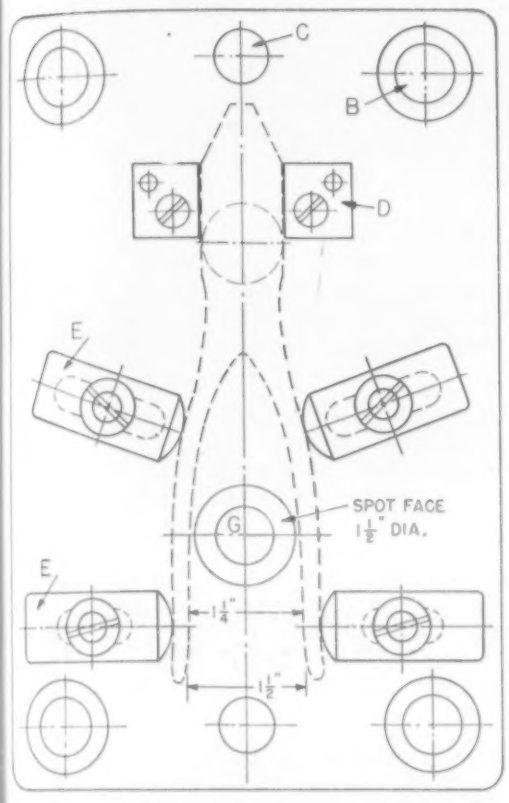
A Handy Bending Fixture

by Robert Mawson

A machine shop producing cutting pliers encountered the problem of meeting the two dimensions on the legs (shown in the sketch), after the parts had been assembled and hardened.



Sketch of bending fixture, showing pliers in position.

At first the shop did the adjusting of legs to obtain these dimensions by hand, using a vise and hammer or any convenient piece of metal. The results obtained were not satisfactory; one of the legs would have all the contour and the other leg was straight, or at other times the contour on the two legs would not be opposite.

To solve the problem, the bending fixture shown was designed and built. This fixture is made with a base "A" of machine steel approximately 5½ in. by 8⅜ by ⅝ in. in thickness. Four resting pins or pads "B", one at each corner, were fastened in the base. Two holes "C" were drilled in the base to fasten the fixture on a bench, where the bending operation was done.

Two hardened steel blocks "D" were fastened on the base, locating them so that the nose of the pliers was a good sliding fit between the blocks. Four pressure locating blocks "E", also made from hardened tool steel, were placed on the base in the positions shown by the illustration.

It will be noticed that these latter blocks can be swung on their fastening screws in various directions, and this feature proved to be the solution of the problem referred to in this article. A bending cam with handle was made from machine steel with the cam surfaces case-hardened.

To use the fixture, one of the pliers is placed with its nose between the blocks "D". The bending cam is then placed in the fixture with the shank of the cam fitting in the hole "G". The man performing the bending operation then pulls the bending cam down by means of its handle and the cam surfaces coming in contact with the inside surfaces of the plier legs force them back to the locating blocks "E".

If the man should find that the contour is not satisfactory or the dimensions have not been obtained, the blocks are moved until the desired contour is made. The screws in the blocks are then tightened down securely and the fixture is ready for production operation.

The principles involved in this method could be used on other bending operations which now use expensive tools and machines and where the results obtained are no better than that from this hand operated fixture.

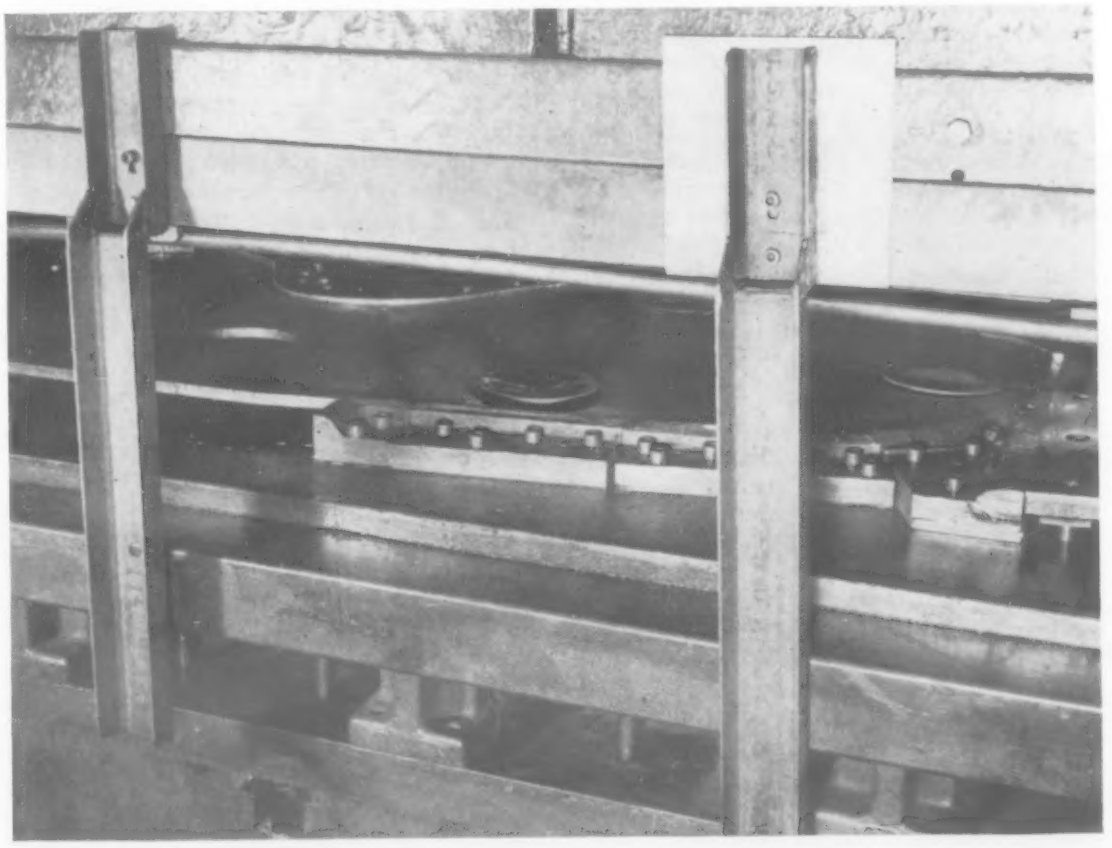
Automatic Handling of Sheet Metal Stampings

by Kenneth Rose, Engineering Editor,

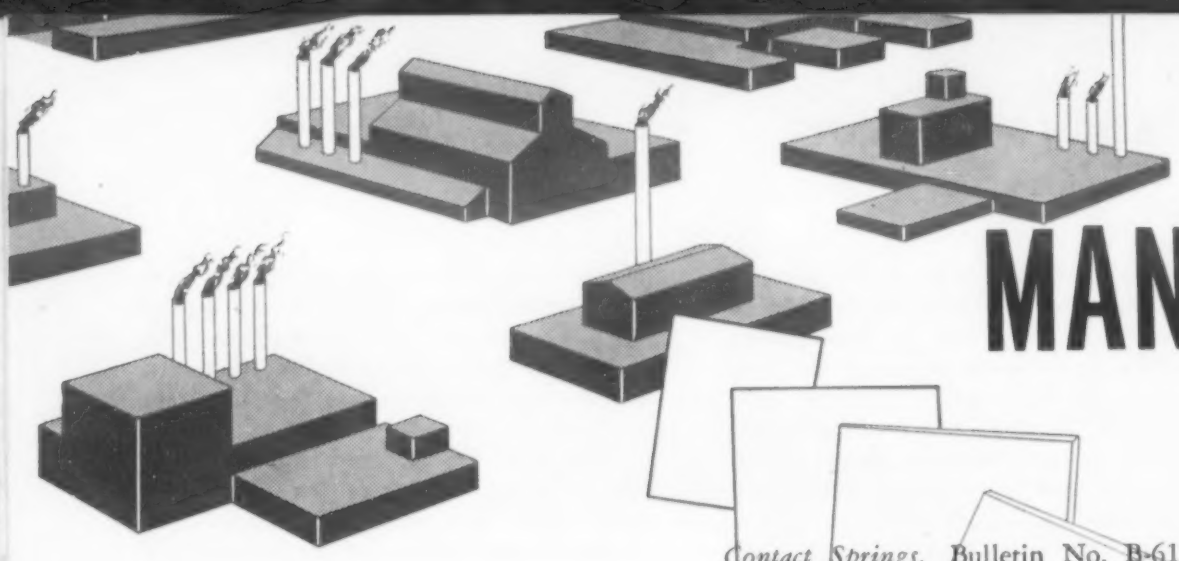
MATERIALS & METHODS

Handling of the large sheet metal stampings used for automobile bodies has always been a laborious job in metal press work. A device produced by engineers at Ford Motor Co. eliminates the manual handling formerly required. It serves to eject these large sheets from the blanking press automatically. When combined with a mechanical feeding arrangement for the steel strip and a conveyor belt for the blanks, it makes the operation of the press truly automatic. The steel is fed through the side of the press, the strip is blanked and the blank is removed from the press and moved into straightening rolls without any manual handling whatever.

The automatic ejector consists of suction cups fastened to the male die, and a moving rack driven by sprockets at the front of the press. When the blank has been punched out, it is lifted with the die during the upstroke of the ram. The suction cups are shown attached to the male die in the figure. The blank is released as the rack slides under it, and is carried forward on the rack. A slide delivers it to a belt conveyor, which in turn feeds it immediately into straightening rolls.



The suction cups shown here in the male die pick up the blanks and deliver them to the moving rack. (Courtesy of Ford Motor Co.)



MANUFACTURERS

Materials

Metal Castings. Numerous strenes metal castings for use in drawing and forming operations are profusely illustrated and described in an 8-page bulletin of *Advance Foundry Co.* (1)

Plastics. Instructions on how to use Urac 110, a white, pure urea-formaldehyde powdered resin, with Melmac 401 for the production of boil-resistant plywood and veneer in the hot press, are presented in a 4-page bulletin of *American Cyanamid Co.* (2)

Felt Base Packing Material. Data Sheet No. 14, published by *American Felt Co.*, discusses Vistex, a sheet laminated felt base packing and sealing material. (3)

Ceramic Property Chart. The mechanical and electrical properties, linear thermal expansion, dielectric strength, and tolerances of AlSiMag ceramics are presented by *American Lava Corp.* in a concise property chart, No. 346. (4)

Springs. The various types of springs produced by *Associated Spring Corp.* and its four subsidiaries are listed in a 6-page, illustrated folder. (5)

Precision Castings. The advantages of using precision castings for parts of complicated shapes are listed by *Bergen Precision Castings, Inc.* in a 4-page, illustrated bulletin. (6)

Plastic Coating. Liquid Envelope, a peelable plastic protective coating for every metal-fabricating operation, is described and illustrated in a 4-page folder of *Better Finishes & Coatings, Inc.* (7)

Industrial Cement. The ability of 4665 Cement to adhere to either porous or nonporous surfaces, such as glass, metals, wood, plastics, etc., is discussed in an 8-page bulletin, No. A-6031, of *E. I. du Pont de Nemours & Co.* (8)

Aluminum Casting Alloys. Specifications, mechanical properties and foundry characteristics of aluminum casting alloys are presented in a 42-page catalog of *Federated Metals Div., American Smelting & Refining Co.* (9)

Tools, Gages, Dies, Etc. The many advantages and facilities of the *Machine Tool & Gage Div.* of the *Fuller Brush Co.* for producing tools, gages, dies, etc. are profusely illustrated and described in an attractive, 44-page catalog. (10)

Contact Springs. Bulletin No. B-61, one page, describes and illustrates beryllium copper electrical contact springs and contact assemblies produced by *Gibson Electric Co.* (11)

Sand Blast Hose. A single sheet, No. 4440, of *B. F. Goodrich Co.* describes and illustrates sand blast hose for conducting sand and other abrasive materials at high velocities for cleaning, cutting or finishing castings, metal surfaces, etc. (12)

Plastics, Coatings, Etc. The numerous products developed by *Hercules Powder Co.* in the plastics, adhesives, coatings, etc. fields are discussed in a 20-page bulletin. (13)

Bronze Bearings. A new type of bearing—pre-cast bearing bronze on steel—which combines the strength of steel and the bearing qualities of bronze is discussed in a 4-page, illustrated bulletin of *Johnson Bronze Co.* (14)

Metal and Plastic Forms. A specialized process of producing long, slender precision metal and plastic forms is announced by *Karge & Son Machine Co.* in a 2-page, illustrated bulletin. (15)

Pig Iron. This attractive, 22-page catalog of *Keokuk Electro-Metals Co.* describes and illustrates their special methods of processing and casting high silicon pig iron, and also shows their many facilities. (16)

Cemented Carbide. The physical and mechanical properties, advantages and applications of Kennametal, a cemented hard carbide, as a cutting tool and wear resistant material, are discussed in a 16-page, illustrated bulletin of *Kennametal Inc.* (17)

Forged Steel Flanges. This 16-page stock list, No. 225, includes specifications and prices of a variety of forged steel flanges in boiler, welding, tank, high hub, etc. types. *Kropp Forge Co.* (18)

Connections and Openings for Pressure Vessels. A variety of press-forged welding necks, nozzles, and elliptical handholes and manholes for use in pressure vessel fabrication are described and illustrated in a 4-page bulletin, No. 4-61, of *Lenape Hydraulic Pressing & Forging Co.* (19)

Valves. Engineering, operating and maintenance data on pressure reducing, differential and overflow valves for steam, air and gas are presented in a 20-page, illustrated bulletin, No. 461, of the *Leslie Co.* (20)

Castings. A variety of applications of Meehanite castings to pressure work in cases where high pressures are required are described and illustrated in a 12-page bulletin, No. 10, of *Meehanite Metal Corp.* (21)

Plastic Fire Brick. The many applications of Mono-Fibrik, a high-grade plastic monolithic fire brick, are discussed in a 24-page, illustrated bulletin of *Mexico Refractories Co.* (22)

Protective Wrapping. The many advantages of using Plastic Seal, a protective skin-tight wrapping that is easily applied and easily removed, are discussed by *Progressive Systems, Inc.* in a 4-page, illustrated bulletin. (23)

Phosphor Bronze. This 12-page, illustrated bulletin of *Seymour Mfg. Co.* lists sizes, specifications, properties, uses, etc., of a variety of phosphor bronze sheet, rod and wire. (24)

Impact Properties of Cast Steels. Complete data on the low temperature impact properties of cast steels are presented in a 4-page, illustrated Steel Casting Report, No. 5, issued by *Steel Founders' Society of America.* (25)

High Tensile Strength Steel. Complete data on the properties, fabrication and application of U.S.S. Cor-Ten, a steel having high strength and resistance to atmospheric corrosion, good workability, weldability, etc., are presented in a 68-page, illustrated catalog of *Carnegie-Illinois Steel Corp.* (26)

Precision Investment Castings. Data on precision investment casting, and the many features of *J. R. Wood Products Corp.'s* precision investment castings, are presented in a 12-page, illustrated booklet. (27)

Methods and Equipment

Dust Collectors. Typical installations of Dustkop dust collectors for collecting dust, lint and rouge from polishing, buffing and metal coloring operations are described and illustrated in a 2-page bulletin, No. 392, published by *Aget-Detroit Co.* Prices are included. (28)

Cutting Tips. Specifications of a variety of Airco cutting tips for use in hand and machine cutting, and for cutting with oxygen and acetylene, are presented in a 6-page folder, No. ADG-1098, of *Air Reduction Sales Co.* (29)

Welding and Brazing Alloys, Fluxes. A complete list of low temperature welding and brazing alloys and fluxes specially designed for cast iron, aluminum, brass, copper and for joining dissimilar metals is presented in a 4-page bulletin of *All-State Welding Alloys Co., Inc.* (30)

New Materials and Equipment

Box Furnace Produces High Automatically-Controlled Temperatures

A new laboratory box furnace for high, automatically-controlled temperatures has been announced by the *Industrial Heating Div., General Electric Co.,* Schenectady, N. Y. Suitable for operation up to 3100 F, the new furnace can be used in such applications as melting and bright annealing of metals, sintering of powdered metals, reduction of metallic oxides, ceramic firing, and copper and silver alloy brazing of metals. Since the heating units must be protected against oxidation, the furnace is limited to operations which can be performed in a protective atmosphere.

This laboratory furnace for temperatures up to 3100 F can be used for heat treating as well as melting and brazing operations.

The heating units are molybdenum rods formed into sinuous loops and supported inside the heating chamber. The heating chamber is 4-in. wide, 4½-in. high, and 25-in. long, and is lined with refractory brick backed by heat insulation.

A cooling chamber permits materials to be cooled in a protective atmosphere, preventing oxidation of the charge. This water-jacketed chamber is separated from the heating chamber by a manually-operated sliding door. The doors of the heating and cooling chambers are provided with manually-operated flame curtains to prevent loss of atmosphere when open.

Automatic temperature control is provided by a standard-type temperature control instrument mounted on an operator's panel. This instrument may be either strip chart, round chart, or indicating type, and operates from a radiation thermocouple focused on the interior wall of the heating chamber.

New Lathe Features Dual Drive

A new lathe with dual driving mechanism has been announced by the *R. K. LeBlond Machine Tool Co.,* Cincinnati 8. It is built with two separate driving arrangements, a gear drive and a direct belt drive. It swings 15 in. over the bed ways, can be built with center distances starting at 30 in., and is powered by a 3-hp. main drive motor.

The lathe has 12 spindle speeds, four of which are high speeds for use with carbide tools. The low speed, or gear drive, runs from the main V-belt motor drive, through a gear train, to the spindle.

The high speed, or direct belt drive, runs through four gear speed changes to a high speed shaft, then direct to the spindle through a second double V-belt drive. Thus, the gear drive is cut out completely, and the high speed drive for all practical purposes is direct to the spindle.

The change feed box is totally enclosed, and the gears are lubricated by oil pumped automatically from the main reservoir. Drive, tumbler and cone gears in the feed box, and many moving parts within the headstock, are flame hardened.

● The *D. E. Makepeace Co.,* Attleboro, Mass., has announced new bar contact services for manufacturing bar contact tape and attaching this tape to contact arms. Palladium and palladium alloys on pure nickel-base bi-metallic bar contact tapes are recommended for use in applications where the current is less than one amp. and where atmospheric conditions are likely to corrode other less noble contact materials. Silver bar contact tapes are recommended for use in applications where the current is less than three amp. They are not as sensitive and usually require greater contact pressures than do palladium and palladium alloy bar contacts.

20 Million-Volt X-Ray Machine Penetrates Heavy Steel Sections

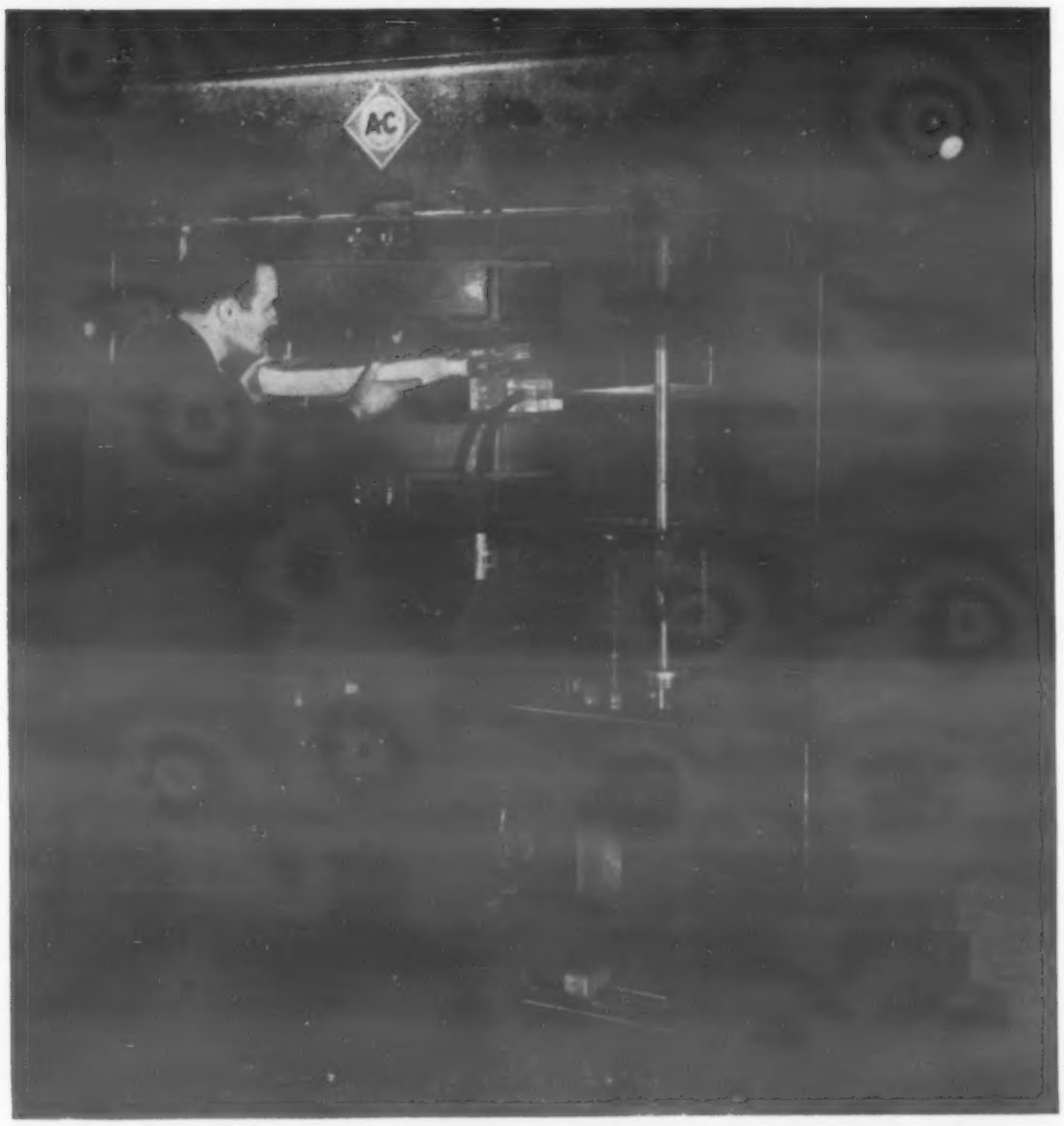
An improved 20 million-volt betatron specially designed for industrial radiography has been announced by *Allis-Chalmers Mfg. Co.*, Milwaukee, Wis. The industrial application of the betatron, as a source of high energy X-rays, was developed during the war, and this latest unit with push-button control is an outgrowth of that war-time work.

The betatron consists essentially of an electro-magnet and a doughnut-shaped vacuum tube placed between the pole faces of the magnet. The supply of electrons is released inside the vacuum tube from a glowing filament and under influence of the magnetic flux, spin around the tube. They are accelerated and when they have reached their maximum energy their orbit is slightly increased so that they strike a platinum target and produce X-rays.

The operation of the betatron has been reduced to three steps. One of the features of the equipment is an exposure control preset. The amount of X-ray energy required to obtain a given film density through the object being X-rayed can be set on the exposure control dial. This control integrates the total exposure by direct measurement of the X-ray beam intensity, and thus automatically shuts off the betatron.

With the X-ray intensities available with the betatron, radiographic inspection of forgings, castings, welds, and machine assemblies up to about 2-ft. thick becomes practical. In a matter of minutes, flaws from 1/32- to 1/10-in. dia. are detected. The characteristics of absolute sensitivity and very weak secondary fog permits the detection of small flaws located at any depth within the specimen.

Additional design changes are in progress to further simplify the betatron. The size of the equipment will be reduced and several of the controls on the present equipment such as the air blower, the ring conveyor motor, and the tube filament current variac will be eliminated or made automatic. (For additional details on multi-million volt X-ray equipment, refer to MATERIALS & METHODS, Mar. 1946, p. 706.)



The new 20 million-volt betatron showing the doughnut-shaped tube being placed in position.

Fiberglas Mat as Base for Laminates

A new-type Fiberglas mat designed as a base, or reinforcement, for low-pressure laminating resins, has been announced by *Owens-Corning Fiberglas Corp.*, Toledo, Ohio. The new mat is particularly suitable for use in laminates that must possess high impact resistance and wet strength. The resulting laminates have equal strength in all directions.

The mat is composed of continuous strands of low-twist, textile-type Fiberglas yarns, laid down in the circular pattern and bonded with a special resin which is compatible with polyester low-pressure resins. The dip method can be employed to impregnate the mat, or it can be laid up dry and impregnated by spraying, dripping or injecting the resin. The binder softens when the mat is warmed to 115 F, permitting preforming to a desired shape before impregnating. Warming will also permit drawing the mat after impregnation.

The mat can be used on the production line to make formed parts by the rubber plunger technique. When this method is used the mat can be pre-cut to the desired pattern, or it can be drawn to the contour of the mold from flat sheet stock and additional resin added. Pressures of 50 to 75 psi. at temperatures of 250 to 300 F are employed to produce molded parts in a curing time of 3 min. in the mold.

Thermosetting Silicone Resin for Bonding Applications

The thermosetting silicone resin designated DC2103, developed by *Dow Corning Corp.*, Midland, Mich., has been further developed and its properties improved. It has use as a heat-stable bonding material for bonding finely divided particles such as powdered metals or mica, silica or carbon, and inorganic fabrics in the production of rigid electric laminates.

The material is a 60% solution of silicone resin in toluene. Its chemical resistance to commonly used inorganic reagents, except concentrated sulfuric acid, and to a lesser extent, concentrated nitric acid, is good. It has limited resistance to organic solvents, being unaffected by the lower aliphatic alcohols and mineral oil, slightly affected by glacial acetic acid, and strongly affected by chlorinated solvents, ketones, esters, light naphthas and aromatics.

Because of its heat-stability, waterproofness and dielectric properties, it can be used as the resin binder in production of heat-stable and waterproof basing cement for sealing light bulbs or radio transmitting tubes to metal bases. It can also be used for bonding finely divided particles such as powdered metals, carbon, carborundum, silica, asbestos or mica, in the fabrication of a variety of products including friction producing materials, abrasive compositions and electrical resistors.

Press Type Spot Welders Employ New Welding Pressure Principle

A new line of press type spot welders which apply the welding pressure in a straight vertical movement of the upper electrode has been announced by the *Taylor-Hall Welding Corp.*, subsidiary of the *Federal Machine & Welder Co.*, Warren, Ohio. This design is a departure from the "radial" pressure approach of the rocker arm type.

The vertical ram on which the upper horn is mounted rides on V-shaped slides (20 in. long). The lower horn has a vertical adjustment of 6 in. and swing adjustment through 90 deg. The upper horn can be adjusted 1 in. out beyond the end of the lower horn.

The welders have a narrow frame that permits a variety of angular work, and less need for extra long horns. The back and sides of the machine are completely flush, valves and switches being recessed in the side panel. Ratings now available are in 5 and 10 Kva capacities.

Direct Drive Grinder for Small Parts

Charles H. Besly & Co., Chicago, has introduced a double verticle spindle grinder designed for high output on small parts.

The new direct drive grinder has a horizontal rotary feed which enables the operator to drop the small parts into the feed wheel rapidly and accurately. For example, the new machine will grind from 3000 to 4000 small coil springs per hr.

This equipment is designed for the grinding of such parts as steel rollers, carbon brushes, washers, and ceramic parts within allowable tolerances.

Free Machining Steel for Die Casting Dies

A free machining medium carbon die steel has been developed by *Vanadium Alloys Steel Co.*, Latrobe, Pa. It has sufficient alloy content to provide air-hardening properties capable of producing a hardness of 275 to 325 Brinell in sizes as large as 20 by 10 in. in cooling in still air. Where abrasion resistance is required, a file hard surface with high core hardness can be developed by pack hardening followed by oil quenching.

The steel is suitable for plastic molds and for die casting dies for white metal alloys. Its free machining quality permits hardening the steel prior to machining. Hubbing impressions in molds or dies is possible with the steel in the annealed condition.

The free machining properties make it possible to place in service dies of higher hardness which better resist the "Brinelling" or peening action of chilled metal and the other hazards of operation. The method of producing the free machining qualities does not impair the surface finishes on molds or dies made from it.

The approximate composition of the steel, known as Speed-Cut, is 0.40 carbon, 0.30 silicon, 0.85 manganese, 1.12 chromium, 0.50% molybdenum.

Storage Battery Machine Flash Welds Aluminum

A new storage battery powered flash welder designed and developed for the flash welding of aluminum has been announced by *Progressive Welder Co.*, 3050 E. Outer Drive, Detroit 12. Although stored energy has been used for resistance welding of aluminum, application previously has been confined to fairly light sections and such operations as spot welding.

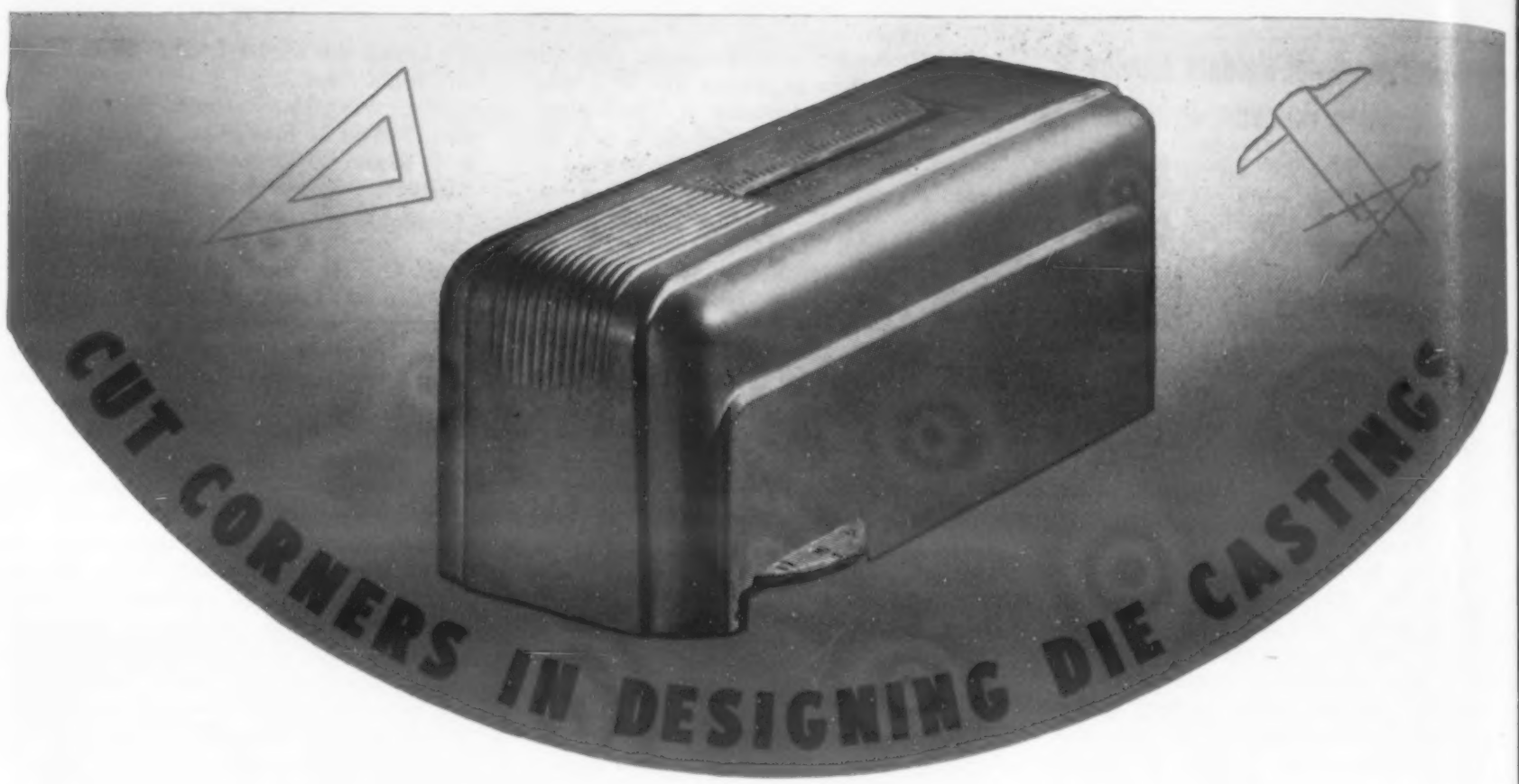
The reason for the use of stored energy, is the excessive power needed for the welding of aluminum. Stored energy machines lend themselves to flash welding because they have the ability to provide high weld current rates with a considerable lower line load than for a. c. machines, and give a continued current flow rather than a single "shot" of short duration as is provided in the other types.

The machine is cam-operated, and has a 16-cell, 8-v. water cooled battery power pack and battery charger and charger control assembly. The power pack supplies up to 38,000 amp.

The battery operated flash welder has demonstrated several useful characteristics in service to date. Apparently it is far less critical as to control requirements when welding light metals than are a. c. machines. A variation of plus or minus 20% in operating voltage or of plus or minus 30% in platen feed rate is apparently permissible without affecting weld quality. Again, where an a. c. machine may often have to be held to plus or minus 1/100 sec. variation in upset current duration, the time can be varied on the battery from 1/20 to 1/6 sec. without affecting the quality of the weld.

While developed primarily for the flash-welding of aluminum, this type of machine probably will also find an important place in the welding of other metals, particularly where semi-portability of welder and power supply is an important consideration. The machines can be installed anywhere where there is adequate power supply to operate a 10- or 15-hp., 3-phase motor.

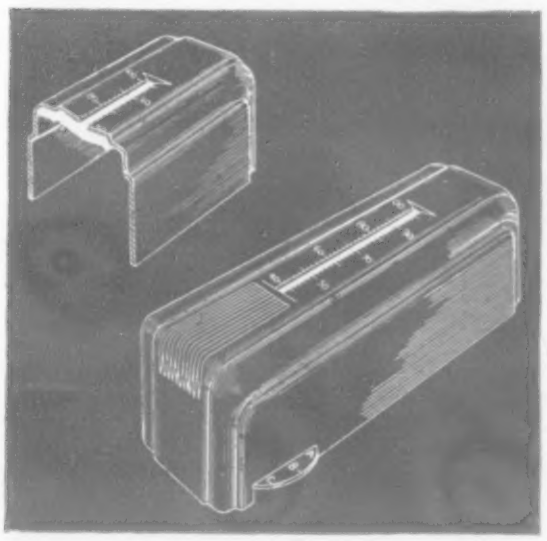
Stored-energy flash welder shown welding miter joints of extruded aluminum window sash.



INCREASE CASTING STRENGTH BY AVOIDING SHARP CORNERS

Die castings can be greatly strengthened by the use of liberal fillets and rounded corners. A radius of .015" minimum is suggested in place of sharp corners, and larger radii are desirable when conditions permit their use. In addition to gaining added strength, a slight radius on corners of castings reduces die cost and promotes the durability of any subsequent plated or organic finish.

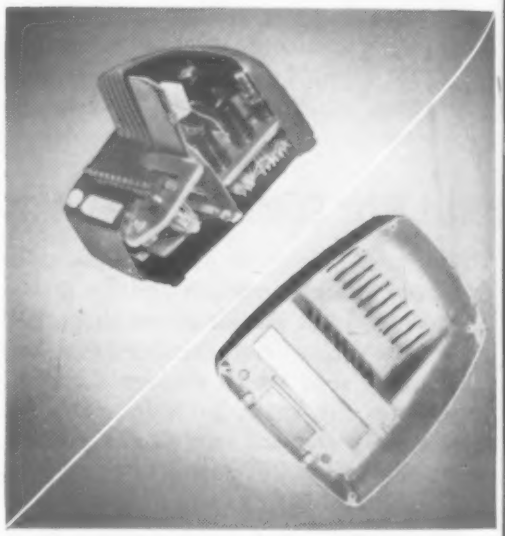
The *zinc alloy* die cast thermostat housing illustrated above and below features thin walls joined by liberal fillets both inside and outside, with no sharp edges except at the die parting. Decorative features, including raised panels on each side, the front and one end, and a series of fine beads, have no sharp external corners. Well filleted inside corners permit the buff to reach all surfaces and facilitate removal of the buffing compound. The absence of sharp corners on the exterior helps to promote a good finish.



DIE CAST HOUSINGS SIMPLIFY ASSEMBLY

Another *zinc alloy* die cast housing, this one for use in an intercommunication system, illustrates the many advantages which can be achieved by this method of production. While handsomely performing the primary function of encasing the microphone, speaker and other internal components, this housing also provides many valuable short cuts in assembly.

Integral bosses permit rapid assembly of the "innards" with just six self-tapping screws. Openings for the microphone, switch panel and control knobs are accurately located in the casting operation. These openings, together with the ventilator openings at the top of the unit, are punched out and cleaned with just three broaching and trimming dies. A sturdy, yet gracefully shaped housing with many cost-saving features is the overall result of this Designing For Die Casting—ask us, or your die casting source, for a copy of the booklet of this title.



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ZINC
FOR DIE CASTING ALLOYS

The New Jersey Zinc Company, 160 Front St., New York 7, N. Y.

The Research was done, the Alloys were developed, and most Die Castings are based on
HORSE HEAD SPECIAL (99.99 + % Uniform Quality) ZINC

Generator for Small and Medium Soldering and Brazing

A new one-kilowatt electronic power generator has been developed by the *RCA Engineering Products Dept.*, Camden, N. J., for brazing and soldering in small- and medium-sized operations.

The generator is a vacuum tube unit which converts the ordinary 60-cycle line power supply to a frequency of approximately 400,000 cycles per sec. It consists of two units—the generator proper and an applicator unit. Only the applicator need be at the work position, and it may be located at any desired position within a 25-ft. radius of the generator. The necessary connecting and remote control cables are provided with the unit.

The generator unit houses the oscillator components, the regulated power supply, the high-voltage rectifier, and most of the high-frequency elements. It also contains an automatic timing device for pre-setting the interval of operation, an automatic overload relay switch, a plate current meter, and indicator lights for plate and filament voltage.

The applicator unit houses the output current transformer and its associated high-frequency "tank" circuit components. This arrangement permits operation of the units at some distance from each other with low transmission line currents, and minimized transmission line losses.

There is no physical contact between the part to be soldered or brazed and the applicator "work" coil. The metal work piece passes through the magnetic field of the coil, where high-frequency currents are induced in the metal to produce the required temperature.

Heating is restricted to the desired area by shaping the work coil to conform to the heating pattern. By the adjustment of power and timing, the depth of heating can also be controlled accurately, permitting the use of techniques impossible with other heating methods.

● A new line of standard truncated cone type spot welding electrodes has been introduced by *P. R. Mallory & Co., Inc.*, Indianapolis 6, Ind. Heat generated in this type electrode during welding is said to dissipate more rapidly, and mushrooming is reduced to a minimum.

Central Atmosphere Generator Serves a Number of Furnaces

A new central station generator that furnishes atmosphere for a number of furnaces has been developed by *Lindberg Engineering Co.*, 2451 W. Hubbard St., Chicago 12. The generator is fully automatic. It requires no charcoal, and does not have to be burned out periodically to remove soot. It produces a clean, dry gas of consistent analysis, with no CO_2, a minus 10 F dew point, and a methane content of 1.0%.

The equipment can be adjusted to produce gas in equilibrium with any steel from 0.05 to 2.0% carbon content. When a single generator is used for a group of furnaces running tool and production medium and high carbon steels, the generator gas is set to be in equilibrium with approximately 1.0 to 1.50% carbon content steel.

An example of the generator's application is the installation at Lindberg Steel Treating Co., where the equipment generates atmosphere for seven furnaces—a brazing furnace, a conveyor, a rotary hearth, two box furnaces, and supplies carrier gas for two carburizers.

All operations of the generator are automatically controlled through push buttons. The unit operates on city gas, natural, propane or butane. It is an endothermic catalytic cracking type—uses only gas for both atmosphere and heating.

Four standard sizes are available—500, 750, 1500 and 2500 cfh. To give some idea as to the floor space required for the equipment, the 1500 cfh unit covers a floor area of 4 ft. by 7 ft., 2 in.; overall height is 7 ft., 1½ in.

Gas Fired Die Cast Alloying Pot Equipped with a Continuous Type Conveyor

Gas fired, die casting alloying pots, ranging in size from 2,000 lb. to 10,000 lb. capacities and fed with a continuous type conveyor, have been announced by *Bellevue Industrial Furnace Co.*, 2971 Bellevue, Detroit 7. Normally they are designed to be fed to capacity every hour; for example, in the case of the 6,000-lb. size, the material is fed to the furnace at the rate of 1,000 lb. every 10 min., giving a total capacity of 6,000 lb. per hr. These units are applicable in die casting plants for reclaiming sprues and other scrap material and can also be employed for alloying die cast metal.

While standard size units are only furnished in capacities ranging from 2,000 lb. to 10,000 lb. per hr., and with a temperature range of 350 to 1200 F, special sizes can be supplied to specification.

With this 6,000-lb. capacity alloying pot, 1,000 lb. of metal can be handled every 10 min.

THE NEW ARITHMETIC IN STEEL

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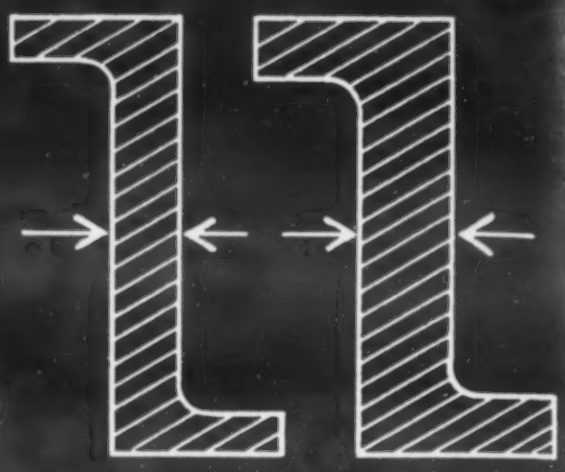
GREAT LAKES STEEL CORPORATION

LIGHTER SECTIONS



=LESS STEEL PER UNIT

=MORE UNITS PER TON

THIS NEW ARITHMETIC SHOWS USERS OF HOT AND COLD ROLLED SHEETS HOW TO INCREASE PRODUCTION OF UNITS 33% WITH THE SAME AMOUNT OF STEEL

Here's a proved and practical answer to the problem of increasing production.

Make lighter sections of N-A-X HIGH-TENSILE steel. Use less steel per unit, get more units per ton. This low-alloy steel is so superior in tensile strength to carbon sheet steel that three tons will ordinarily do the work of four. Yet, with all its strength, N-A-X HIGH-TENSILE can be formed and drawn to intricate shapes because of its exceptional ductility.

You'll find other important advantages in N-A-X HIGH-TENSILE steel—excellent weldability, high fatigue- and corrosion-resistance, great impact toughness. This means a better and more durable product . . . and simpler and less costly fabricating, finishing and handling operations.

Until our metallurgists and engineers know more about your particular products and production methods, we can't tell you exactly how much N-A-X will help you. We're ready to investigate at your request.

MAKE A TON OF SHEET STEEL GO FARTHER
Specify—
N-A-X
HIGH-TENSILE STEEL

GREAT LAKES STEEL CORPORATION

N-A-X ALLOY DIVISION • DETROIT 18, MICHIGAN
UNIT OF NATIONAL STEEL CORPORATION

Chrome-Cobalt High-Speed Steel Used for Taps

A chrome-cobalt high-speed steel, designated M-11, specially developed for taps and threading tools is now being used by *Detroit Tap & Tool Co.*, 8432 Butler St., Detroit, for its line of standard and special taps carried in stock and other special taps designed and produced to special order.

The steel is said to have: higher resistance to abrasion than other high-speed steels; higher toughness with high hardness, resulting in less chance of tooth breakage; higher red hardness, which permits efficient use of taps made of M-11 steel at drill speeds or even higher; and higher torsional strength, which imparts to the tap greater resistance to twisting and breakage, particularly under momentary overload conditions.

Mechanical Oscillator Simulates Dynamic Stresses

For simulated service tests of parts under dynamic stresses, *Baldwin Locomotive Works*, Philadelphia 42, has developed a portable mechanical oscillator for inducing vibrations on structures and assemblies. It is known as the Sonntag LA-1 Oscillator.

It is reported that over 80% of the service failures in machines and structural parts involve dynamic forces, and present design trends are emphasizing the importance of dynamic forces as factors in design.

The design engineer can carry out his dynamic testing by using specimens to determine fundamental properties of materials in the initial design stages, but to check actual serviceability of the machine or structure, and to refine the design, the actual assemblies should be subjected to tests. No test, of course, could be as good as actual service, but this usually is impractical because it takes too long and is too expensive. For that reason the modern engineer subjects his structure to simulated service tests.

In use, the oscillator, which weighs 61 lb., is attached to the structure or machine. The centrifugal force produced by eccentrically supported weights, rotated so that all forces add in one direction and cancel each other in all other directions, provides the vibration for the test.

This oscillator weighs 61 lb. and can be attached easily to a structure to induce vibrations in dynamic testing.

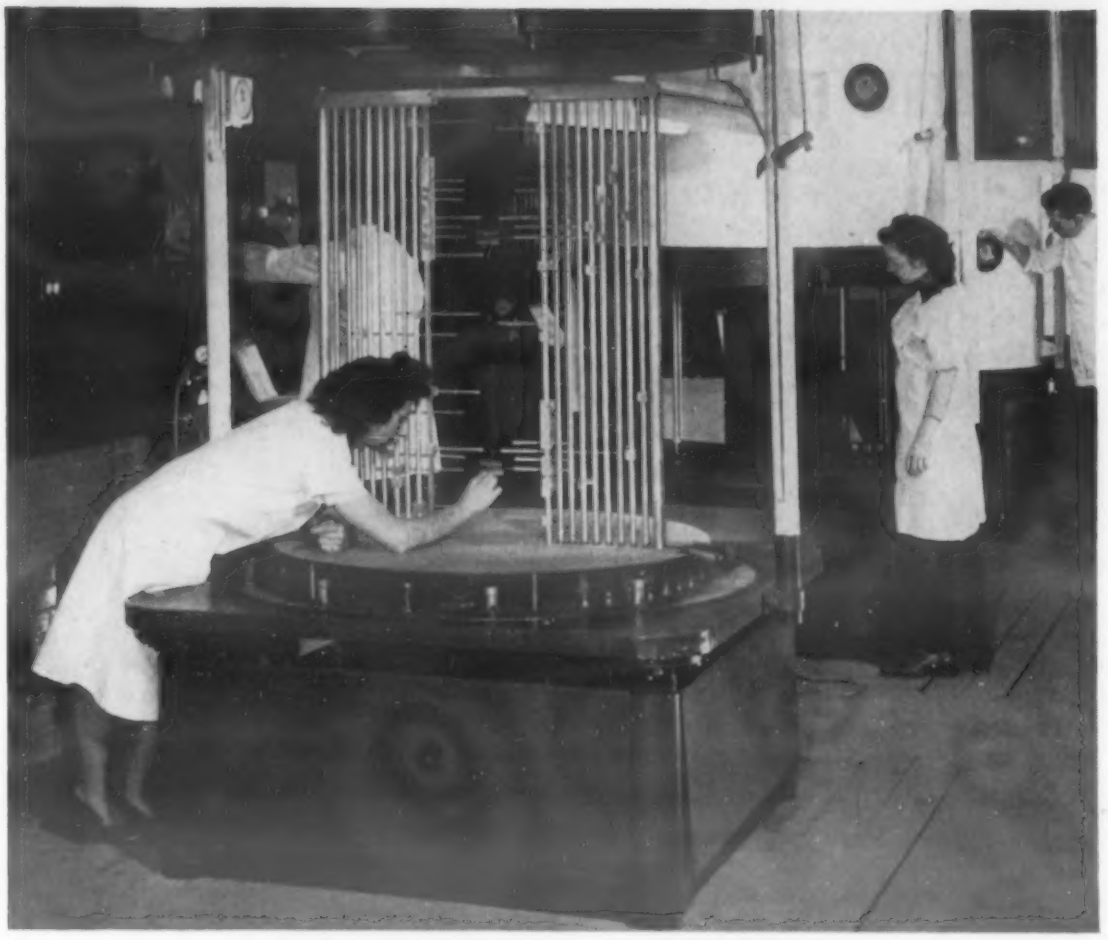
The force is steplessly adjustable either while running or stationary by turning the micrometer type knob. The maximum allowable force of the machine itself is 1600 lb., but this is multiplied in resonance with the structure under test. The multiplication factor is determined by the damping of the structure. Factors as high as 200 have been encountered, making the machine in effect capable of producing loads of 1600 by 200, or 320,000 lb.

New Profilometer Tracer Is Self-Adjusting

A new self-adjusting, hand-operated Profilometer Tracer has been introduced by *Physicists Research Co.*, Ann Arbor, Mich. Known as the Type MA, the new tracer replaces the Type M Tracer as standard equipment with all Profilometers.

The new tracer eliminates the adjustment of the tracing point to the surface being measured. Operation consists of placing it on the surface, moving it to and fro, and noting the microinch reading.

The new tracer is also smaller than the old type; it will go completely through 1½-in. I.D. Only two skid yokes are needed to handle all surfaces. No adaptations are needed to use the Tracer with any Profilometer now in use.



Seeing Through Mirrors Now Possible

The world's first volume production of transparent mirrors—glass that transmits light as well as reflecting it—has been announced by *Liberty Mirror Div., Libbey-Owens-Ford Glass Co.*, Brackenridge, Pa. The thermal evaporation chambers shown above are used to surface glass by a method of molecular "bombardment" with chrome particles. This is the first peacetime application of a highly secret wartime advance in glass technology.

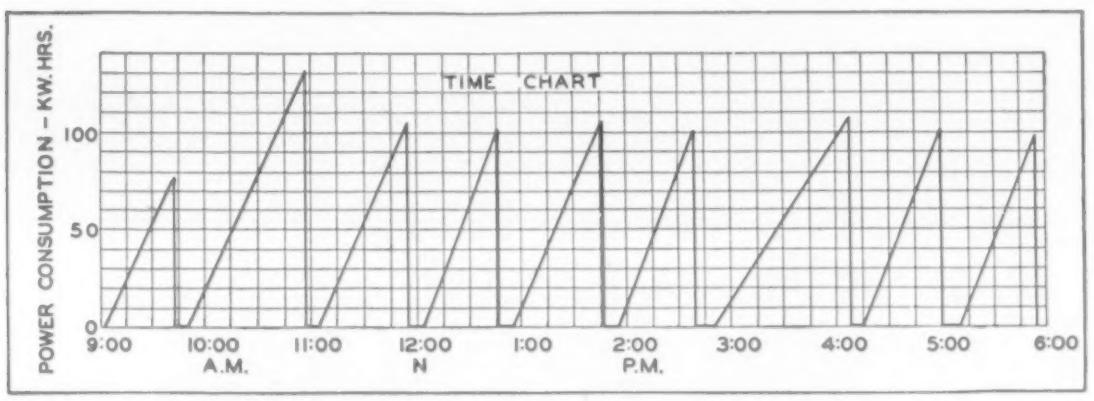
Electronic Heat Controls on Plastic Molding Machine

Hydraulic Machinery, Inc., Dearborn, Mich., has announced a new 2-oz. plastic injection molding machine with two electronic controls that regulate the heat in the chamber and nozzle indefinitely without danger of burning the material. A new type electronic control mounted on the machine panel gives an accuracy of ± 2 deg. The control is so mounted that it is not affected by machine vibration.

Although this machine is rated at 2 oz., it has actually been designed and built with a 50% overload capacity, so that it is capable of handling a wide range of small plastic parts and products. It is suitable for the production of small units of automotive body appointments, toys, novelties, notions, costume accessories and jewelry.

DAILY OPERATING RECORD OF SMALL DETROIT ELECTRIC FURNACE MELTING GREY IRON

DAILY GRAPHIC OPERATING RECORD, TYPE LFC, 350 LB. DETROIT ROCKING ELECTRIC FURNACE, MELTING HIGH QUALITY GREY IRON FOR CYLINDER LINERS.



SUMMARY: HOURS OPERATION 9; NO. HEATS, 8; WT. PER HEAT, 375 LBS.; TOTAL METAL MELTED, 3000 LBS.; KWH TOTAL, 931; KWH PER TON, 620.

Let's take a look at the facts from the daily operating record of a Detroit Rocking Electric Furnace covering a 9-hour working day.

Making high quality grey iron for cylinder liners, from borings, scrap and ferro-alloys, a Type LFC, 350 lb. Detroit Rocking Electric Furnace poured 8 heats in the 9-hour period, each heat weighing 375 lbs., for an output of 3000 lbs. Melting time per heat was 49 minutes; elapsed time per heat, (after the first heat which included preheat period), was 56 minutes. Because the design of Detroit Furnaces permits close control over time, temperature, composition, and other vital melting factors, an engineering product of superior wear resistance is produced. And cost? Consider the low priced raw materials used—consider the quality of the product—and only 620 Kw. hrs. per ton!

Records like this are incontrovertible evidence that Detroit Electric Furnaces are fast melting, economical, efficient. They are your assurance that Detroit Electric Furnaces, installed in your own foundry, will do a faster, more versatile job of melting ferrous and non-ferrous metals. Write for further facts.

DETROIT ELECTRIC FURNACE DIVISION
KUHLMAN ELECTRIC COMPANY • BAY CITY, MICHIGAN

Many Companies Announce New Lines of Welding Electrodes

A number of new electrodes for a variety of welding applications recently introduced are listed and discussed briefly below.

The *Air Reduction Sales Co.*, 60 E. 42nd St., New York 17, has introduced a group of automatic arc welding wires and tapes. This new line includes five knurled type wires and five tapes for flat position operation. Their applications on the production line range from thin gage sheet metal forms to boilers, axle housings, and torque tubes. They are manufactured in several diameters and are designed to meet the general requirements of high-speed production welding. These automatic wires can be used separately or in conjunction with the tapes, depending upon the job to be performed.

A new line of stainless steel electrodes in a full range of grades and diameters has been introduced by the *Electric Welding Div., General Electric Co.*, Schenectady, N. Y. The electrodes are available in two types of coatings, one designed for a. c. or d. c. use, and the other for reverse polarity d. c. operation. They can be used in all welding positions. Stability of the arc and deposition characteristics is said to assure flat fillet welds; stable arc characteristics also permit good directional control.

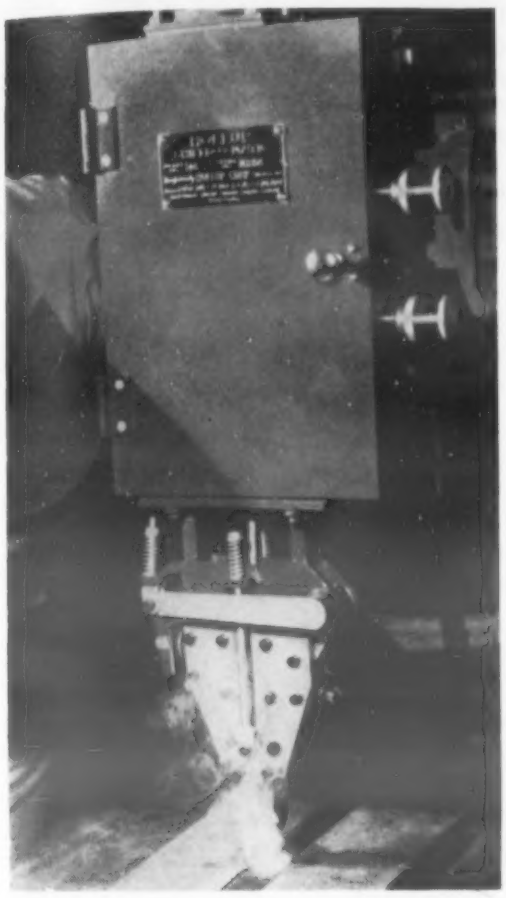
High-carbon electrodes for building up worn steel parts by welding with low-voltage a. c. transformers, as well as d. c., have been announced by the *Lincoln Electric Co.*, Cleveland. The new electrodes, designated as Hardweld 40 A.C. and Hardwell 100 A.C., have a heavily extruded shielded-arc-type coating, are said to produce flat, smooth beads, and the deposits can be hot-forged. Hardweld 100 A.C. has a hardness of deposit on straight carbon steel when allowed to cool naturally of 20 to 45 Rockwell C. Hardweld 50 A.C. on straight carbon steel has a hardness of 20 to 35 Rockwell C. Deposits can be further hardened by water quenching from approximately 1500 F or by flame hardening.

A new electrode for welding of high sulfur, free-machining steel and of certain high tensile, low-alloy steels, is also announced by the *Lincoln Electric Co.* It has a low-hydrogen, low-moisture coating, and is designed for use with d. c. polarity. The welded tensile properties are 70,000–80,000 tensile strength, and elongation is 25 to 30%. An interesting application for the electrodes is in the arc welding of materials which have to be enamelled. Where it was formerly necessary to heat treat the vessels to drive out the hydrogen after welding in order that the enamel would not bubble and seal, enamelling can now be done without heat treating.

All-State Welding Alloys Co., Inc., 96 W. Post Rd., White Plains, N. Y., has announced the addition of two new nickel-silver welding rods to its line of low-temperature welding and brazing alloys and fluxes. One of these rods is suitable for production and fabrication of light steel and nickel alloy sections and also for low-temperature welding of steel, stainless steel, copper nickel and nickel; the other is applicable wherever resistance to frictional wear is desired and especially for work on worn or broken parts.

(Continued on page 145)

A new type automatic welding electrode has been developed by the *Hollup Corp., Div. of National Cylinder Gas Co.*, 3357 W. 47th Place, Chicago. Known as the Shield-O-Matic, the construction includes a metallic framework extending outwardly from the coil wire, through a thick coating of flux, to the periphery of the electrode.



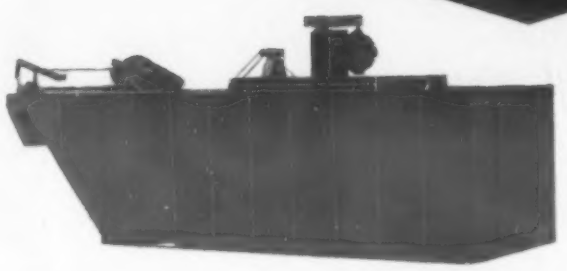
Automatic welding electrode in operation on a 1-in. plate.

This framework consists of fin formations on the coil wire, around which are helically wrapped a plurality of fine wires. This construction permits the electrode to undergo flexing and bending without breaking away of flux. At present, electrodes for welding low and medium carbon steel, and low alloy high strength steels are in production. Products which can be fabricated using this electrode include parts from light gage sheet and strip as well as heavy plate products such as cracking towers, pressure vessels, and heavy machinery parts.

● A new lubricant for pressure die casting dies has been developed by *G. W. Smith & Sons, Inc.*, 5401 Kemp Rd., Dayton, Ohio. Known as Die Slick No. 11, it is a colorless, odorless compound that is non-staining, non-corrosive, non-carbon-forming and causes no objectionable smoke or gases. The lubricant is applied as a fine spray to the die. It eliminates scoring and sticking, and assures easy ejection of the casting. It prevents formation of zinc oxide on the core pins and die cavities.

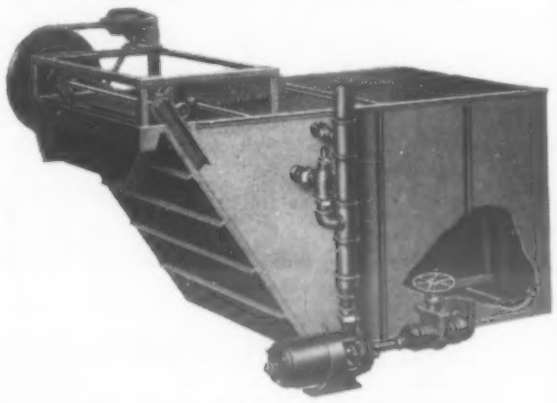
SAVE 1. ON PRODUCTION COSTS
2. ON MAINTENANCE COSTS
3. IN REDUCED REJECTS

WITH HOFFMAN FILTRATION EQUIPMENT



FLOTATION EQUIPMENT

Hoffman flotation equipment provides a simple method of maintaining a full flow of clean coolant to the work. It is fully automatic, the system is compact and the action is entirely mechanical; no added material is necessary.



VACUUM FILTERS
UP TO 500 GALS. PER MIN.

Hoffman Vacuum Filters are self-cleaning, continuous-operating units that increase production, lengthen life of machines, cutting tools and grinding wheels plus the fact that they are easily installed.

PRESSURE FILTERS
FOR FINE FILTRATION

Designed for use with approved filter-aid powder, Hoffman Pressure Filters are widely used for filtering straight oil coolants – especially those of heavier viscosity – where finest clarity is required.

PLUS coolant temperature control units and vacuum stills for solvent recovery . . . and a specialized engineering service that solves your filtration problems.

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COOLANT FILTERS • FILTRATION ENGINEERING SERVICE

"FALLS BRAND" ALLOYS

AMERICA'S LARGEST PRODUCERS OF ALLOYS

"FALLS" MANGANESE COPPER

Manganese copper is used principally for the introduction of Manganese into brass, bronze and nickel silver. It is supplied in the form of shot or bars that can be cut to any reasonable weight that the user may require.

GRADE "A"—will conform to the following composition:

Manganese	28.5 to 31.5%
Total Impurities	0.5% Maximum
Copper	Balance

GRADE "B"—will conform to the following composition:

Manganese	25.0 to 30.0%
Total Impurities (Principally Iron)	3.0 to 5.0%
Copper	Balance

FALLS MANGANESE COPPER is also used for deoxidizing brass, white nickel casting alloys and nickel silver containing lead. As well as being an active deoxidizing agent Manganese has great affinity for sulphur and this combined with its ability to absorb gases makes "FALLS" MANGANESE COPPER a very important alloy for use in the foundry.

Write for Complete Details

NIAGARA FALLS

Smelting & Refining Division

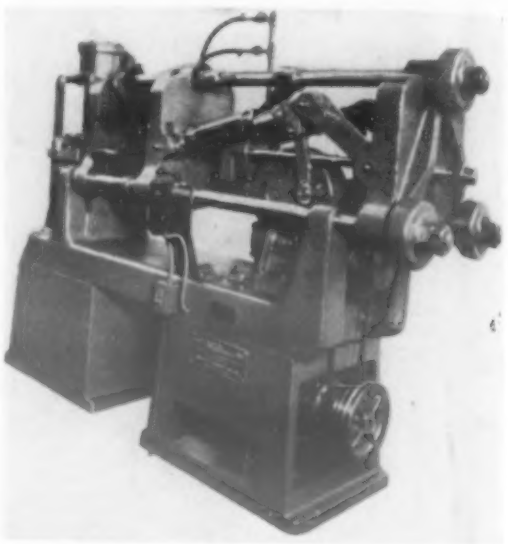
Continental-United Industries Co., Inc.

BUFFALO 17, NEW YORK

Die Casting Machine Features Automatic Cycling Mechanism

A new, automatic, die casting machine for production of zinc, lead and tin parts has been announced by *Light Metal Machinery, Inc.*, Penton Building, Cleveland. Between-cycle delays are eliminated by a patented cycling mechanism that provides for automatic die movement, shot and ejection in continuously repetitive cycles. The machine can be operated at any one of four fixed speeds: 240, 330, 520, and 720 shots per hr.

Because of the high cycling speeds, zinc, lead and tin castings can be made in single cavity dies successfully. Through the use of single cavity dies, die cost is reduced considerably.



This fully automatic die casting machine for production of zinc, lead and tin castings makes practical the use of single cavity dies.

Shot capacity is 16 oz. with a casting area of 30 sq. in. Small ¾-oz. castings are being produced by users from single cavity dies at 720 shots per hr. Larger 9½-oz. castings are being run at 240 shots per hr. with single cavity dies. Ribbed castings, such as padlock cases, weighing 1¼ oz., are produced from 4 cavity dies at 520 shots per hr.

Solution Prepares Aluminum for Painting or Lacquering

Colonial Alloys Co., Tech. Processes Div., Philadelphia, has announced a solution, known as Paintbond, for preparing aluminum and its alloys for painting or lacquering. The nature of aluminum and the thin oxide which is always present on aluminum gives to the surface poor adhesion properties and makes it impractical to paint or lacquer without proper pre-conditioning.

Using this solution, the aluminum can be sprayed, brushed or dipped; dipping is preferable. The procedure consists of freeing the aluminum of greases and dirts, and immersing in the solution for about 30 to 60 sec., then rinsing and drying. The metal is then ready for painting or lacquering.

Primers that are suitable for aluminum should be used prior to final finish coats.

Ram-Type Milling Machine Has Adjustable Cutterhead

The *Van Norman Co.*, Springfield 7, Mass., has announced a new ram-type milling machine especially designed for use in pattern shops, tool rooms, tool and die shops, laboratories, and machine shops.

The machine has a high column that provides greater vertical range, which is important in those shops where a greater clearance between the cutterhead and lowest position of table is required. It is also designed to bring the table nearly up to the center line of the spindle (horizontally).

It incorporates an adjustable cutterhead mounted on a movable ram. Thus, milling can be performed from horizontal or vertical to angular. The adjustable cutterhead permits the machine to meet fluctuating milling requirements in those plants or departments where milling requirements continually change.

Specifications of the machine are listed below:

Table size —50 in. by 10 in.
Range —Longitudinal, 28 in.; cross, 10 in.; vertical, 20.
Speeds —9 spindle speeds from 40 to 1100 r.p.m.; 12 table speeds, 0.5 to 36 in. per min.
Weight —3650 lb. with plain saddle
Floor space—98 in. by 72 in.

● The *Rhodes Industrial Corp.*, East Hampton, N. Y., has announced a new laboratory packing gland for use with a ¼-in. shaft. The packing gland will permit flask stirring rods. The gland comes equipped with several different washers to permit its insertion in rubber stoppers to fit flasks having neck sizes from 1-in. up.

Sound Gage Measures Thicknesses from One Side

Branson Instruments, Inc., Joe's Hill Rd., Danbury, Conn., has announced the development of a portable thickness gage designed to measure the thickness of materials, including steel, from one side only. Among its applications are thickness determination of pipes, storage tanks, pressure vessels, and ship hulls.

The instrument, known as Audigage, utilizes a crystal-type gage head, powered by a frequency-modulated electronic oscillator. When the vibrating crystal is applied to a wall surface, mechanical resonance of the wall thickness can be produced directly below the crystal. The fundamental frequency at which the wall section will reso-

(Continued on page 148)

MAC DERMID
Bright Copper
Plating Process

MAC DERMID Bright Copper Plating Process produces Mirror Bright deposits from simple cyanide copper plating solution over a wide range of operating conditions with a deposit that is *bright for any thickness of plate.*

- Mirror bright deposits obtained directly from bath. Simple steel equipment used throughout.
- Operates at low temperature and low metal concentrations. Any conventional type copper anode may be used.
- Simple water rinse required after plating prior to other plating processes such as bright nickel or chrome.

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ENGELHARD

Portable Indicating Pyrometers

Engelhard Portable Indicating Pyrometers combine the necessary attributes of accuracy and instancy which distinguish the completely efficient precision instrument.

High resistance per millivolt assures a degree of accuracy unaffected by connecting lead length or by thermocouples of different resistances.

Direct deflection construction permits instantaneous readings easily in either millivolts or degrees.

The conveniently portable instrument is a complete unit in a sturdy carrying case with removable cover.

The 6" scale length indicator may be calibrated with 100 to 150 divisions. Scale range may be selected to suit specific applications. Every indicator is equipped with the Engelhard frictionless moving coils.

All indicators may be furnished with two scale calibrations —for rare metal and base metal thermocouples. By a simple change of lead connections readings are made on either scale.

WRITE FOR BULLETIN 400

CHARLES ENGELHARD, INCORPORATED

90 CHESTNUT ST., NEWARK, NEW JERSEY

nate is directly proportional to the velocity of the sound in the material and inversely proportional to thickness. The wall thickness will also resonate at all harmonics of the fundamental frequency.

The device provides a means whereby audible signals are produced corresponding to harmonic resonance. The frequency difference between any two adjacent audible signals as read on the tuning dial is readily converted into wall thickness on a concentric thickness scale.

This thickness gage can also be used to indicate the kind of material, height of liquids and condition of reflecting surface.

The instrument can be used to provide information other than thickness. The character of the audible indications varies with several factors, such as kind of material, condition of reflecting surface, back-up liquids, process scale, etc. These factors provide useful information, but do not influence the accuracy of the thickness measurement.

Semi-Automatic Lathe Has Automatic Chuck

A single spindle lathe equipped with four-speed motor, hydraulic feeds and semi-automatic features has been announced by the *Oster Mfg. Co.*, Cleveland 3. The machine is furnished with either single action or double action cross slides. The hydraulically operated cross slide with necessary valves and other control features provides an automatic cycle of approach, feed, dwell, retraction and stop.

The cross slide is actuated by a 3½-in. dia. hydraulic cylinder which is controlled through the action of a lever and solenoid operated valve. When desired (chiefly for set-up purposes) the solenoid can be disconnected from the circuit.

The automatic chuck is equipped with a draw-back collet with an adjustable work stop in the spindle. The collet is operated by means of a hydraulic cylinder with a 2-in. bore and 2¼-in. stroke. Collet is controlled by a lever-operated valve mounted on the bed, below the cross slide.

The machine weighs about 3,000 lb. Dimensions are: height, 50 in.; width, 44½ in.; length, 79 in. overall.

Aluminum Melting Furnace Cuts Oxidation Losses

The *Ajax Engineering Corp.*, Trenton, N. J., have announced a new 125-kw. induction melting furnace for aluminum and aluminum alloys. Designed for the melting of finely divided aluminum alloy particles like turnings, chips and unbaled foil, this furnace is operated on the twin coil induction principle. It is claimed that oxidation losses are reduced considerably, and that yields of 95 to 96% of the dry weight of the charge are obtained with this unit, because of the rapid melting and the low temperature prevailing in the hearth during the melting operation. The unit can be connected to the standard frequency power lines of 60, 50, or 25 cycles.

The tilting of this induction melting furnace is arranged so that all the molten metal can be easily discharged.

The pouring spout is located in line with the rotating axis of the furnace; therefore, it is easy to adapt them for direct pouring into molds. Tilting is accomplished by a hydraulic ram with a flexible chain. The electric controls are concentrated in an internally wired self-contained control cubicle, which also houses the temperature control instrument. Also, the supporting frame for the furnace and for the tilting ram is self-contained, so that this melting unit does not require elaborate foundations.

● A method of cutting polystyrene, acrylics, and other plastics materials in such a manner that no subsequent sanding is necessary to obtain a highly polished surface has been developed by *Howard H. McNash*, 576 S. Falmouth Dr., Cleveland. Transparent slit cuts can be made into polished parts, and gates removed in one operation. The method can be applied for use to an electric saw in a few minutes time.

SHORT OF CADMIUM?

TRY Luster-on* on zinc

No question about it—cadmium is hard to get! But *Luster-on* on zinc may be your answer!*

Luster-on* produces attractive brilliance and passivity on zinc—giving a bright surface which resists stains, fingermarks and white corrosion. It gives to zinc plate an aging resistance, appearance and protection equal or superior to cadmium plate at a lower cost.

Luster-on* does not impair electrical conductivity or interfere with spot welding, and provides an adhesive base for lacquers and cements.

Successful Luster-on applications include:*

Ventilation Equipment	Radio Parts
Fastening Devices	Electrical Fittings
Machine Parts	Builders' Hardware
Hand Tools	Automotive Parts
Sporting Goods	Nuts and Bolts
Refrigerator Shelves	Toys

Send the coupon and a sample part for processing today! See the results for yourself. No obligation.

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THE CHEMICAL CORPORATION
54 Waltham Ave., Springfield 9, Mass.

Please send me full particulars about Luster-on* bright dip for zinc surfaces. I am (am not) sending sample part for free dip. No obligation, of course.

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Strip Nickel faster and better with . . STRIPODE!

Speed-up the action of your regular sulphuric acid strip bath by adding Stripode. Salvage plating racks in less time with less acid. Stripode helps protect the base metal from pitting and roughening. Send for free sample. Start savings right away!

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Please send me full information and free sample of STRIPODE for better nickel stripping.
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Continuous Process
Cyaniding
Drawing
Enameling
Forging
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Nitriding
Normalizing
Oil Tempering
Preheating
Salt Drawing
Special Process

For Every Purpose

•

For many years the American Electric Furnace Company has been pioneering, developing, manufacturing and shipping industrial furnaces to all parts of the world.

We have solved many difficult problems and are continually solving others as the demands of industry present them. We may be able to solve your problem . . . at substantial savings. Why not write us today and take advantage of our experience?

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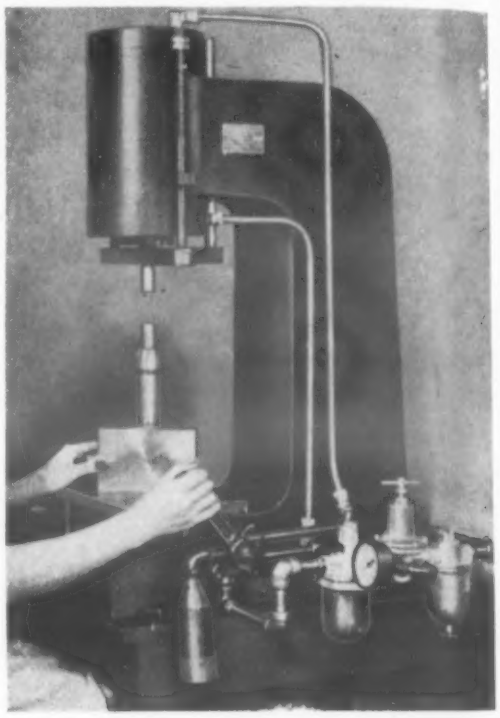
Industrial Furnaces for All Purposes

Air Powered Arbor Presses Have Adjustable Ram Stroke

Two new air powered arbor presses have been announced by the *Studebaker Machine Co.*, 1221 S. 9th Ave., Maywood, Ill.

Double acting air cylinders are used on both models. The one develops one-ton ram pressure on the down stroke at 80-lb. air line pressure and one ton on the up stroke. At 120-lb. air line pressure it develops 1½ tons ram pressure on both the down and up strokes. The other develops two-ton ram pressure on the down and up strokes at 80-lb. air line pressure and three tons at 120-lb. air line pressure.

These air presses give up to 200 punch press ram blows per min.; however, the ram can be regulated to a very slow squeezing action if desired. The presses are suited for light push or pull broaching jobs as well as for fast assembling, stamping, forming, riveting, punching, cutting and other punch press operations.



This 1-ton air powered arbor press in operation gives up to 200 punch press ram blows per min.

Diamond Compound Polishes Precision Parts

A research project recently completed by *Sapphire Products Div., Elgin National Watch Co.*, Elgin Ill., has resulted in a new diamond polishing compound for use as an aid in the fashioning of precision parts. It is composed of close-grained, virgin diamond powders which through its paste vehicle are kept in uniform suspension. The vehicle is non-toxic and non-deteriorating.

The compound has been used successfully

(Continued on page 151)

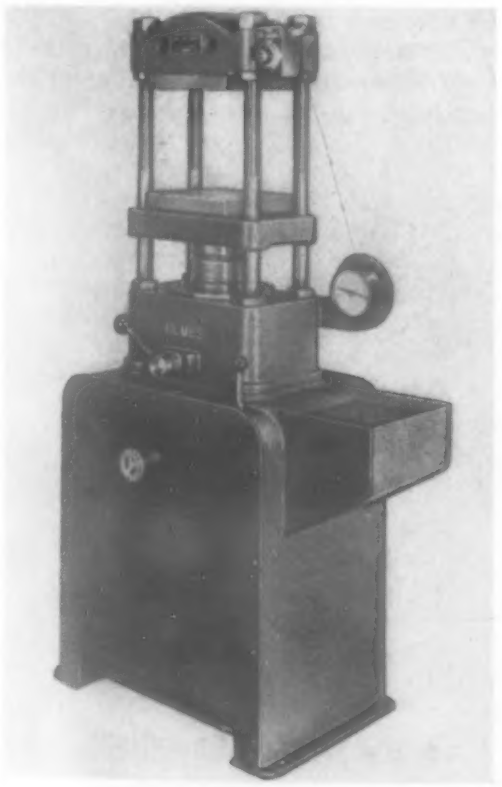
for final polishing of industrial sapphire products, such as jewel bearings, precision gages, and machine wear parts; also for the manufacture of precision steel and tungsten carbide products. Another use of the compound has been found in the finishing of the surfaces of steel molds used for plastic molding.

The job of making diamond powders begins by placing raw commercial diamonds in a mortar and pounding them with a pestle. The powder that this produces next is placed under automatically-operated hammers and further pulverized.

Then the diamond particles which make up the powder are segregated and graded for size. Final grading occurs in the employment of a new dispersing method developed by Sapphire Products.

New Press Has No Motor or Pump

A new line of high-production, power-operated, hydraulic presses that have neither motor nor pump has been announced by *Elmes Engineering Works,* 1002 Fulton St., Chicago 7. Compressed air from shop line, introduced above the liquid, provides the power for closure and full pressure. It applies and maintains the desired pressure within the capacity range, and repeats at that pressure until reset. This hydraulic principle is said to promise greater economies in the molding of plastics and rubber,



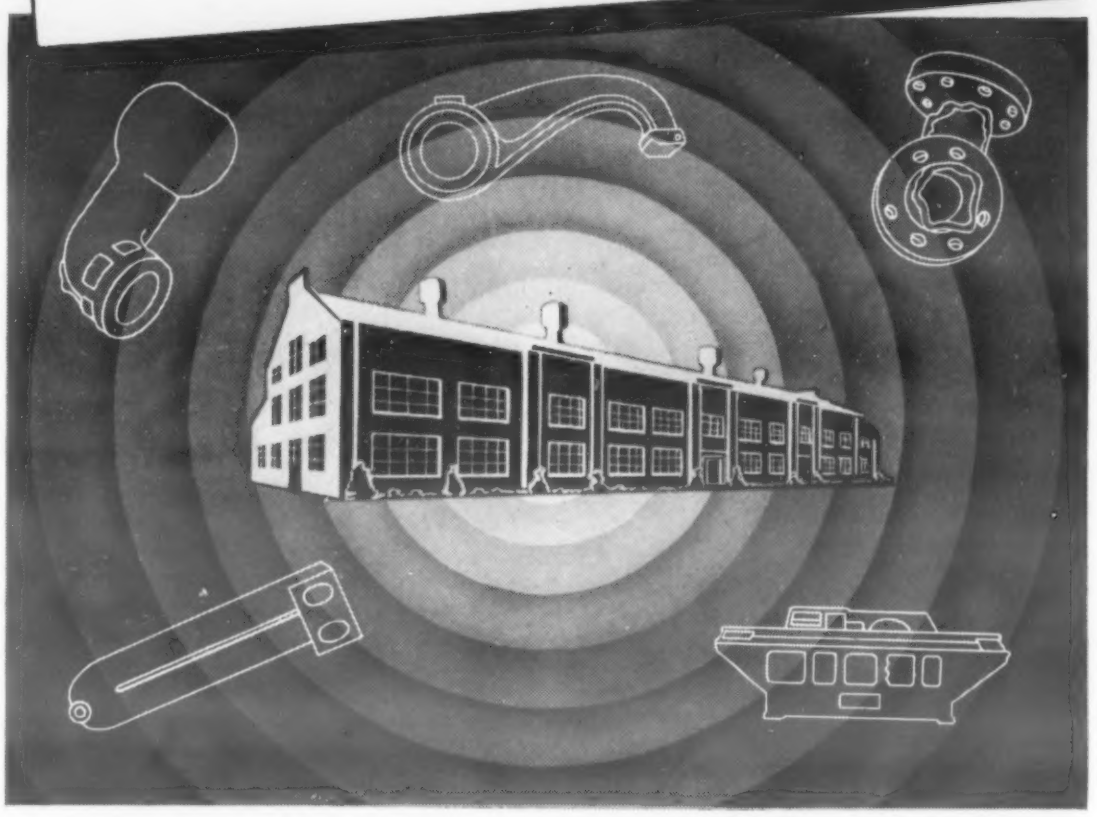
Compressed air in conjunction with the hydraulic system operates this press.

in assembly forcing, straightening, and testing.

The presses are made in 20- and 30-ton bench-type and floor-type models, and in 50-ton floor type. The 30-ton floor-type has 6-in. stroke; opening adjustable from 0 in. to 13 in.; can be equipped with 10 by 10-in. hot plates.

"Not only to serve today, but to anticipate tomorrow"

CENTRALIZED RESEARCH



...permits close control of castings

ABSCO Controlled Castings offer to design engineers and to production executives — ferrous and ferrous alloy parts that are cast to close tolerances and produced under strict control. These tolerances are much closer, this control is far stricter because of the centralized research and engineering facilities with which American Brake Shoe Company backs its foundries.

A complete metallurgical department to develop the proper metal for your specific application . . . a fully-equipped experimental foundry to pilot difficult jobs — these are parts of a research and engineering center serving every user of Absco castings.

No matter whether the best castings for your purpose prove to be Meehanite, ABK Metal or a controlled Gray Iron alloy . . . no matter whether your Absco castings are produced at our foundries in Mahwah, N. J., Melrose Park, Ill., or Baltimore, Md., you benefit from the skill, knowledge and equipment at the disposal of Brake Shoe's technical, engineering and foundry production personnel.

Write us detailing the performance conditions under which the castings you use are to serve. Let us tell you then how centralized research can put close control of castings to work for you.

AMERICAN Brake Shoe COMPANY

BRAKE SHOE AND CASTINGS DIVISION
230 PARK AVE., NEW YORK 17, N. Y.

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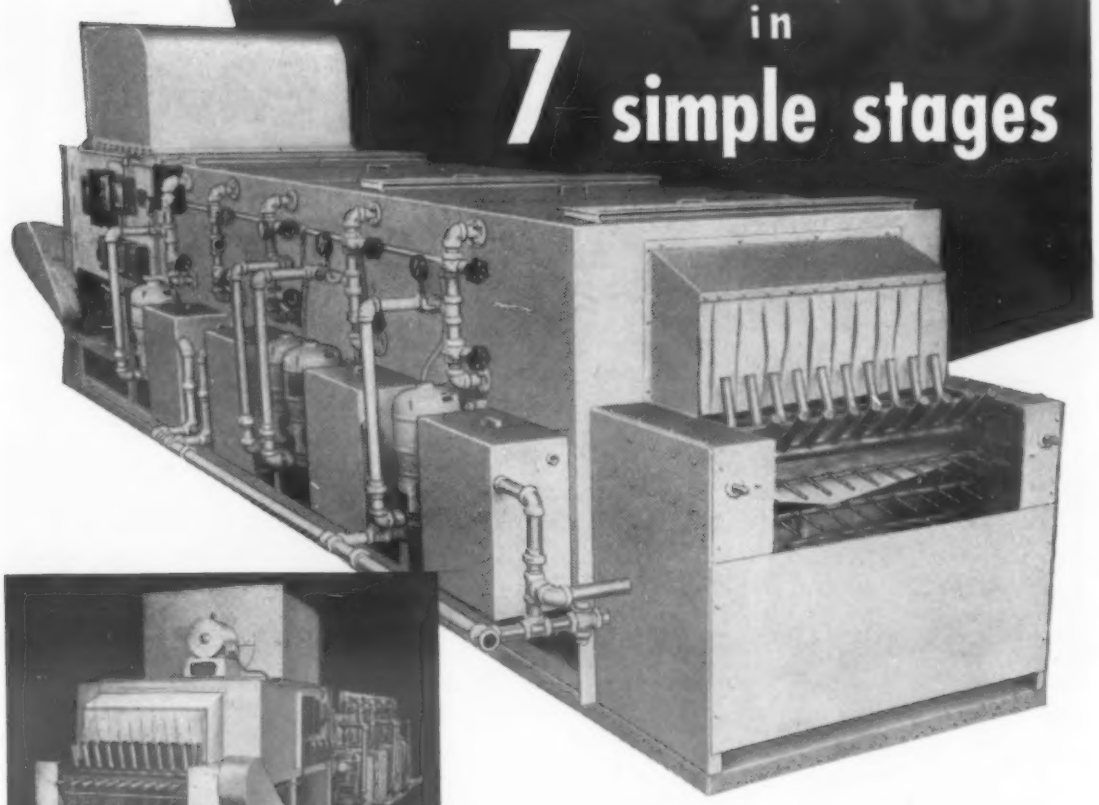
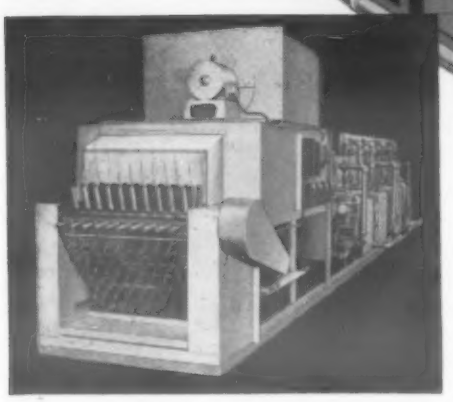
Speedier CLEANING in 7 simple stages





ABOVE: Loading end of Machine

LEFT: Discharge end of Machine

The cleaning of cylindrical brass cases following polishing and directly prior to plating, was a problem in a large metal parts manufacturing plant. The **OPTIMUS** Flat Conveyor Type Washing Machine shown above, now handles this operation in seven simple consecutive stages: Hot Alkali Wash, Drain, Hot Water Rinse, Warm Sodium Cyanide Wash, Cold Rinse to Sewer, Hot Rinse, Dry.

The entire operation takes the parts directly from polishing and feeds direct to the plating machine, the entire cleaning operation being timed to fit in with these other steps. The two hot rinses are hooked in sequence, thus effecting a further operating saving. Conveyor can also be built with flight bars for baskets and individual pieces, or with a mesh belt for any type of parts in bulk or individual pieces.

- *The* **RIGHT** *Machine*
- *The* **PROPER** *Detergent*
- *The* **CORRECT** *Cleaning Method*

OPTIMUS
Provides them all!

An **OPTIMUS** Plan for the mechanized handling of your metal parts through washing, degreasing, rinsing and drying, can assist you in saving labor, materials and speeding up production. Submit your problems to **OPTIMUS.**

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ENGINEERS AND MANUFACTURERS
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STANDARD AND SPECIAL TYPES OF EQUIPMENT FROM THE SMALLEST TO THE LARGEST SIZES FOR A WIDE VARIETY OF OPERATIONS.

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FOR CLEANING · RINSING · DEGREASING · PICKLING AND DRYING OF METAL PARTS

Rotary Spindle, Quench Combined in One Induction Unit

A hydraulic rotary spindle and quench ring, combined in a single unit, is a development of the *Induction Heating Corp.*, 389 Lafayette St., New York 3. Designed for use with any type of induction heating equipment, the unit is applicable to the heat treating of parts requiring rotation during the heating cycle and subsequent quenching in position.

The work piece is located on a spindle, which is actuated by a water driven turbine,

This combined rotary spindle and quench accessory for induction heat treating operations is actuated by a water driven turbine.

fed through standard hose and nozzle attachments at the base of the unit. The speed of rotation is controlled by varying the flow of water.

This combination unit is portable, can be moved from one coil to another, and therefore is useful for short runs and experimental work, where rotation and spray-quenching are required. For long run jobs, the unit may be anchored permanently in position by substituting lock nuts and bolts for the rubber suction cups.

Such parts are gears, splines, pulleys and similar circular pieces can be handled in this unit.

Metallizing Unit Used for Spraying and Welding Operations

A new type of powder metallizing unit, known as the Spraywelder, has been announced by *Wall Colmonoy Corp.*, 19345 John Rd., Detroit 3.

The metallizing unit was developed for use in conjunction with the Spraywelder Process. The unit is operated in the first part of the process as a powder metallizing unit to apply a uniform overlay of the surfacing alloy. It is then used as a conventional welding torch to fuse the sprayed

(Continued on page 153)

overlay to the base metal to obtain a fusion or molecular bond, identical to that obtained when the same alloy in rod form is applied by acetylene welding.

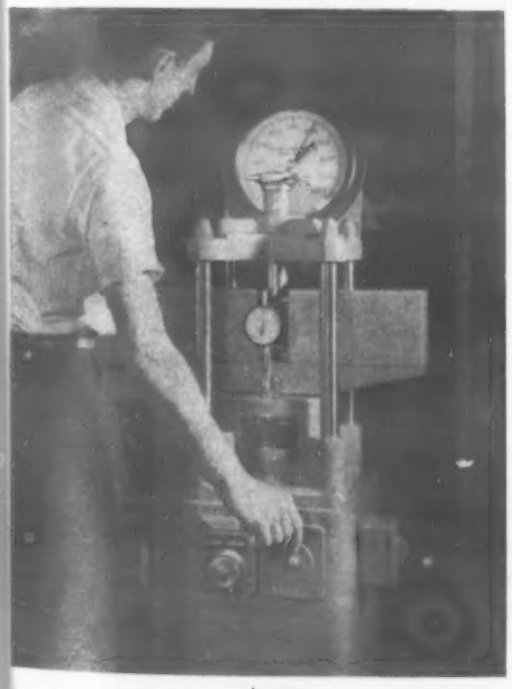
The new unit has only two control valves, both of these being mounted on the gun itself. Once adjusted, the powder flow can be stopped and started by pressing or releasing the trigger. The gun can be hand operated, or held in a vise or with an attachment in the toolpost of a lathe, and is capable of being operated in all positions.

The unit consists of the gun, all necessary hoses, with connections. The hopper for the powdered metal and the carburetor are combined in a single unit. In addition, a panel to hold all of the equipment is provided.

Transverse Testing Machine Has 10,000-Lb. Capacity

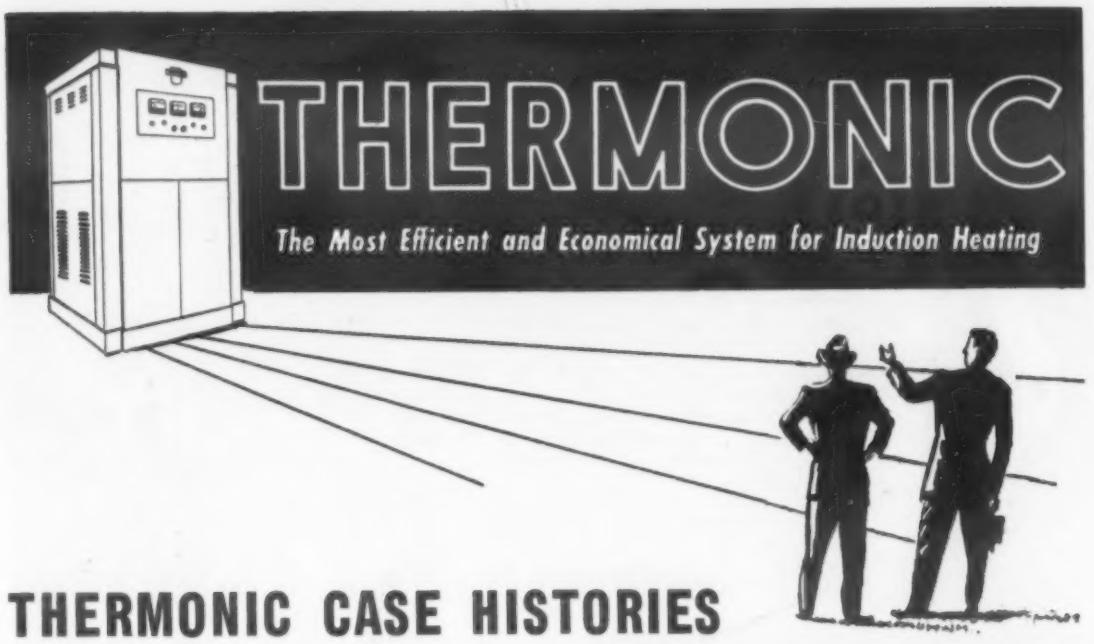
A transverse testing machine with a capacity up to 10,000 lb. that is hydraulically operated has been announced by *Steel City Testing Laboratories,* 8843 Livernois, Detroit 4. The machine is highly sensitive and is adaptable to making transverse tests with equal accuracy and efficiency on various specimens up to its full capacity of 10,000 lb.

The load is applied automatically; when the speed has been selected, the specimen



Load is applied automatically on this transverse testing machine.

is loaded on the supports and the load lever raised. Reversing the procedure returns the ram to its original position. The gage has a maximum indicating hand which remains stationary when the specimen breaks, permitting the operator to get readings even though he is not looking at the dial when the ultimate breaking point is reached.



THERMONIC CASE HISTORIES

PROBLEM: To harden threads on 1" diameter lead screws.

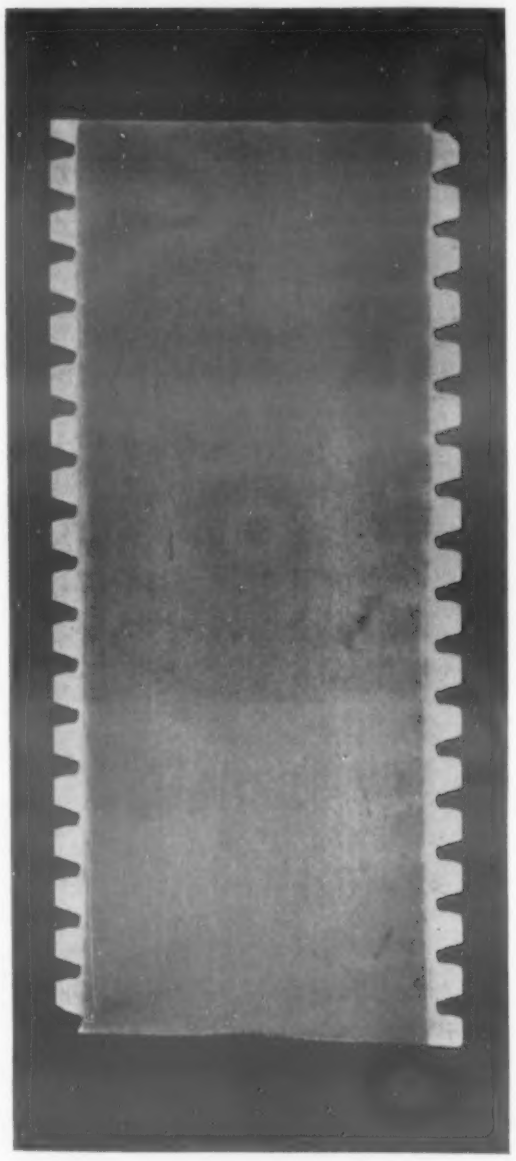
MATERIAL: S.A.E. X-1335 steel.

PRODUCTION RATE: 9" per minute.

COIL: Multi-turn, cylindrical-type heating coil.

EQUIPMENT: One Model 1070 THERMONIC Induction Heating Generator; progressive feed fixture and immersion-type oil quench.

REMARKS: Lead screw threads (Acme) are chased on a lathe prior to heat treatment, leaving between 0.020" and 0.022" extra stock for final grinding on precision thread grinders. The screw is held in place and aligned by a self-centering chuck. A variable-speed drive motor rotates the screw at 70 R.P.M. and feeds it progressively downward through the heating coil, and into a circulating oil quench immediately below the coil. Hardness obtained on the lead-screw thread section is 52 Rockwell C. (See macrophoto at right). Lead elongation is limited to a maximum of only 0.0009" per foot of screw length. Distortion, scale formation and decarburization are negligible.



Longitudinal Section of 1" Dia., Lead Screw, Showing Induction Hardened Thread Section before grinding

•

Photo reproduced through the courtesy of Monarch Machine Tool Co.

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INDUCTION HEATING CORPORATION
389 LAFAYETTE ST. · NEW YORK 3, N. Y.
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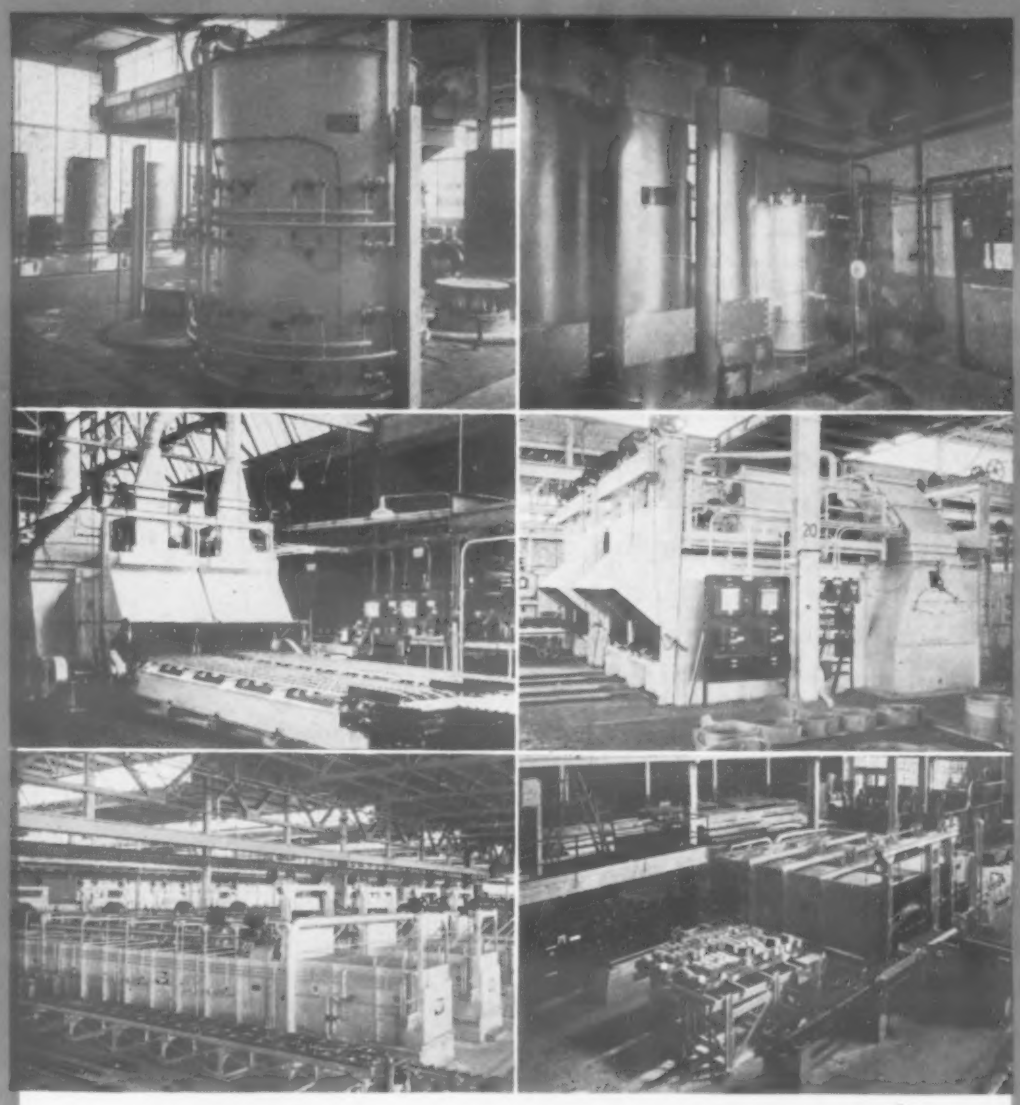

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ASSOCIATE COMPANIES
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Engenheiros Continental do Brazil, S. A.

Band Saw Cuts Variety of Materials

The *Ermac Co.*, 5531 So. Vermont Ave., Los Angeles 37, has a new 12-speed band saw for cutting materials such as wood, plastic, aluminum, cold rolled steel, angle iron, tool steel or cast iron.

The range of materials that can be sawed is possible because of the 12 speeds from 85 ft. per min. to 1750 ft. per min. This

This band saw has a range of 12 speeds from 85 to 1750 ft. per min.

permits adjustment to the right speed for each material, plastic, metal or wood.

General specifications are: capacity of throat (blade to frame), 17½ in.; table to guide, 10½ in.; floor to table, 44 in.; overall height, 72 in.; width, 38 in.; breadth, 20 in.; floor space required, 39 by 39 in.

The frame is of cast iron alloy, precision machined in one operation to assure close tolerance. The 20 by 20-in. table, of cast iron alloy, tilts to 45 deg. for angle sawing by half turn of socket-head cap screw.

Vapor Degreaser Uses Controlled Cool-Air Principle

A vapor degreaser employing a controlled cool-air principle has been developed by the *Mabor Co.*, Clark Township, Rahway, N. J. The degreaser is self-distilling and self-contained. Built-in storage tanks are provided as part of the unit. Its contents can be distilled without danger of overheating, because the machine is equipped with a jacket heating system.

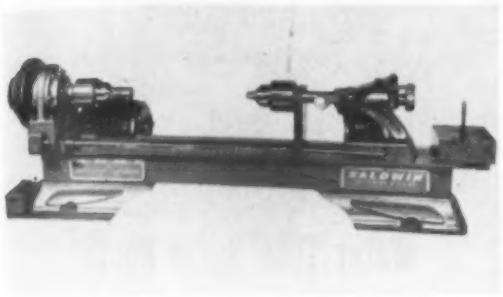
By increasing the flow of cooling air, vapor level oscillation is reduced and as a result, the consumption of solvent is also reduced proportionately. An extra heater, foot petal operated, helps to increase the vapor formation and overcome the shock load as work is placed in the machine.

The unit can also be used on light metals, as a hand hose, and flush pump (supplied with the machine) will take care of lighter gages which do not condense enough solvent vapor for effective cleaning.

New Furnace Maintains Temperature Within 10 F

A new automatically controlled furnace has been developed for precision use in laboratories, small unit and batch production work by the *K. H. Huppert Co.*, 6830 Cottage Grove Ave., Chicago 37. Termed the Huppert No. 5 De Luxe, the furnace has a combination three-way heat range switch and an automatic temperature timer which allows the operator to maintain constant temperatures ranging from 200 to 1800 F, with a minimum variation of not more than 10 deg., and also to bring the furnace to heat fast or slow as desired.

Heating elements are of high-temperature alloy wire. The unit is heavily insulated,



This torsion testing machine will test bronze, copper and steel wire.

and the door is counterbalanced to insure complete closure while in operation. The furnace proper is divided from the base by a transite spacer, to prevent excessive temperatures in the lower base where the instruments are located.

Built-in temperature controller and heat range switch, a pyrometer, two porcelain loading trays, and two pilot lights for indicating operation of the furnace are included as standard equipment. Dimensions of the work chamber are 4¾ by 3¾ by 9 in. Overall measurements are 19 by 21 by 21 in., and the furnace's throat measures 2 in.

Electric Handtool Features Speed and Versatility of Use

An electric handtool and portable grinder for grinding, drilling and polishing metals and nonmetallic materials is being manufactured by *Precise Products Co.*, 1328-30 Clark St., Racine, Wis. The tool has a precision quill fitted with a No. 0 Morse Taper for interchangeable mounting of collet chucks for rotary cutters and millers. It also has a Jacobs chuck for small or special arbors for unmounted grinding wheels and diameter drills. Special spindles can also be mounted to extend the quill length for internal grinding and engraving.

The unit can be used alone as a handtool or mounted in a stand, vise, lathe, or milling machine. It is contained in a plastic case, weighs 40 oz. and has a 1/5-hp. motor and speeds to 40,000 r.p.m.

Some of the jobs it can be used for include cleaning, deburring, and polishing small parts, castings and stampings of ferrous and nonferrous metals; die sinking steel and carbide dies; milling unhardened steel and cast iron; and sharpening all kinds of cutting tools.

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SILVER BRAZING ALLOY

For clean, sound leakproof joints of

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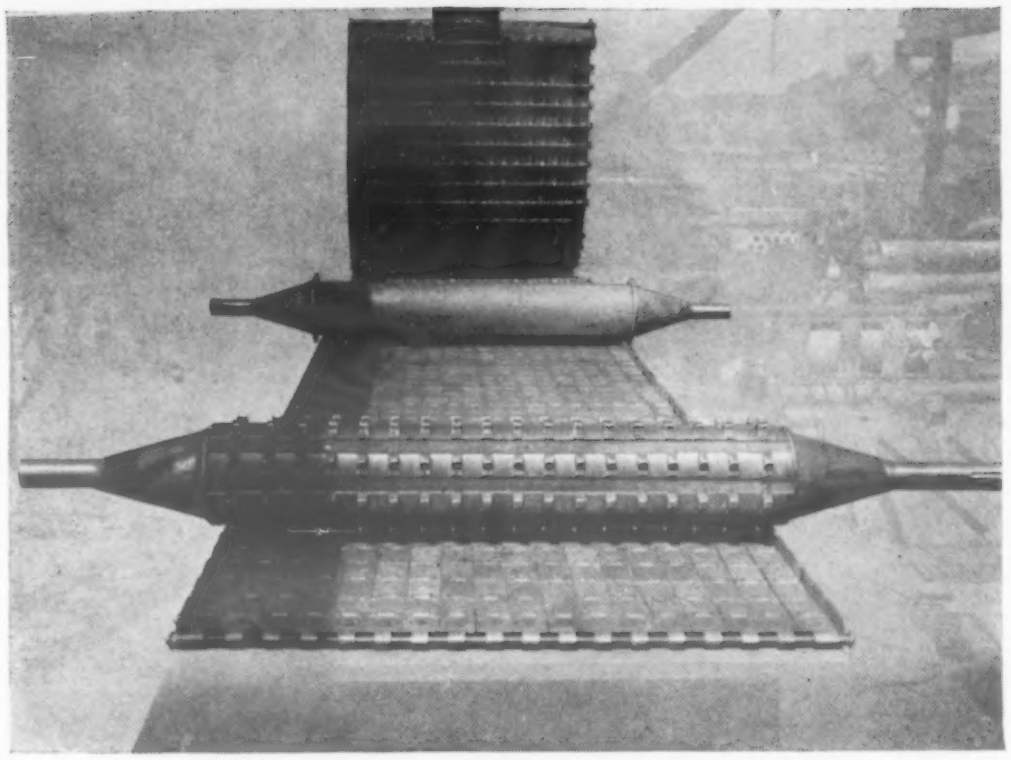
DURALOY DURASPUN

HERE'S ONE OF OUR MORE DIFFICULT JOBS



It's a conveyor assembly for a heat-treating furnace, alloyed and cast for a large manufacturer of automobile parts. Perhaps you would be interested in some facts:

Alloying Elements . . 15% Chromium, 35% Nickel
Conveyor Belt . . . . 8,400 pounds, statically cast
Head Shaft . . . . . 1,625 pounds, centrifugally cast
Tail Shaft . . . . . 804 pounds, centrifugally cast

The belt consists of several thousand individual links assembled and held together by alloy steel rods. No machining of the links was necessary. The lugs on the head shaft were cast integrally with the shaft. The end cones on both shafts were cast statically and then welded on.

You may not need a conveyor for a heat-treating furnace such as this, but if you need *any* high alloy casting—for resisting heat, corrosion or abrasion—we would like to discuss producing it for you. Our experience in static castings goes back to 1922 and in centrifugal castings back to 1931, both pioneering dates.

THE DURALOY COMPANY

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1-DU-1

Torsion Machine Tests Variety of Wire Products

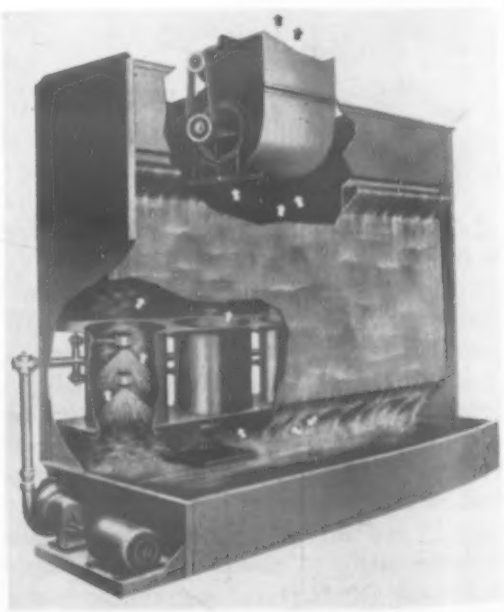
A new torsion testing machine for wire, developed by the *Sonntag Scientific Corp.*, is being marketed by the *Baldwin Locomotive Works*, Philadelphia 42. The machine will test bronze and copper trolley wire, telephone and telegraph wire and steel tie wire with diameters from 0.090 to ¾ in. in dia. in accordance with ASTM specifications.

Three twisting speeds, 10, 20 and 30 rpm., with reversible rotation, are available with a maximum torque of 1000 in. lb. Stresses up to 80,000 psi. can be obtained on ½-in. specimens. The specimen can be preloaded in tension, and a reset type counter disengages automatically when the specimen fails.

Water Tube Spray Booth Has Built-In Discharge Fan

A new water tube spray booth of the water curtain type is being produced by the *Neucomb-Detroit Co.*, 5741 Russell St., Detroit 11. The equipment incorporates the use of a series of tubes to clean the paint-laden air. Inside each tube are two high velocity, clog-proof nozzles which wash the air twice. The air is then drawn by suction through moisture separators and discharged.

A feature of the design is that the discharge fan is built-in. This eliminates the necessity for construction and installation of an overhead platform, mounting the fan, motor and drive on this platform, and the alignment of this equipment with the suction pipe running from the top of the booth. It also permits movement of the entire unit when necessary.



This water tube spray booth has clog-proof nozzles and washes the air twice.

Also, the water recirculating pump and motor are mounted directly to the tank making an integral unit. This permits assembly of the pump suction and spray header prior to shipment.

Emulsifying Agent Increases Safety and Efficiency of Petroleum Solvents

A new emulsifying agent designed for use with kerosene and other petroleum cleaning agents to remove very heavy deposits of oil and light grease from metal parts and equipment has been introduced by *Turco Products, Inc.*, 6135 S. Central Ave., Los Angeles 1. In solution with petroleum cleaning agents this product, known as Mulsirex, adds to the cleaning potency of these agents and because of its high flash point (180 F) increases the margin of safety for the operator.

The emulsifying characteristics of this product make foreign substances readily soluble in water, a feature that permits the deposits to be flushed away after application of the cleaning agent with a cold water rinse.

It can be used in dilutions as high as 1 to 10 with solvents and can be applied with a spray, brush or mop, or as a cold tank immersion solution. It is harmless to metals and enameled surfaces.

Plastic Coating Tanks Have Mechanical Agitation

For plastic skin protective coating dipping operations, the *Aeroil Products Co.*, 5701 Park Ave., West New York, N. J., has developed two new hot dip tanks, one of which has explosion fittings for compounds of high vapor transmission.

The two models provide variable speed mechanical agitation by means of an air powered turbine motor. Safety control is provided through use of double thermostatic reaction coupled to automatically controlled cooling system. There is provision for rapid cooling of melt when necessary to allow the user to change the viscosity of skin coating. Indirect heating by means of an agitated hot oil bath is thermostatically controlled at any temperature from 100 to 550 F.

Both tank and cover of these units are insulated to conserve heat during non-dipping periods. Hinged housings protect parts from dripping compound. Built-in dial thermometer and thermostat with knob dials and pilot lights provide for visible check of oil bath temperatures.

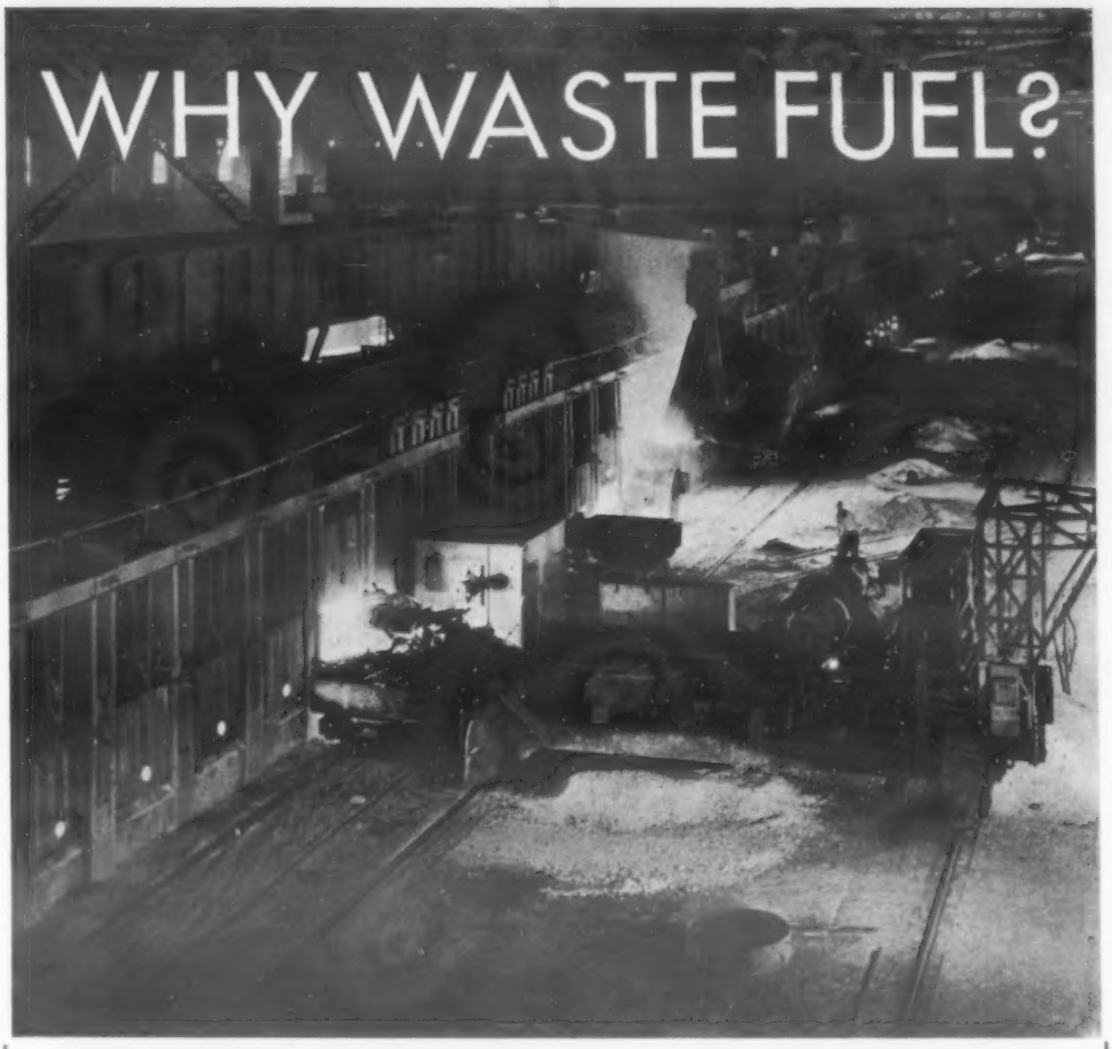
Tool and Wheel Dresser Forms Any Angle

A new tool and wheel dressing fixture, called Gem-Flex, has been recently put in production by *Allied Machinists*, 6 Water St., Waltham, Mass. It can be used to form any angle in addition to a number of inside and outside radii.

Among its uses are the following: (1) in forming toolbits, thread chasers and small dies; (2) as an indicator stand; (3) as a surface gage (it scribes circles or chords of circles in either vertical or horizontal planes); and (4) in backing-off operations.

The fixture is machined from quality

(continued on page 158)



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Therm·O·flake ENGINEERS will prepare an accurate fuel economy survey of existing furnaces in your plant and submit complete thermal data and recommendations for safe maximum insulation of any open hearth furnace, on request.

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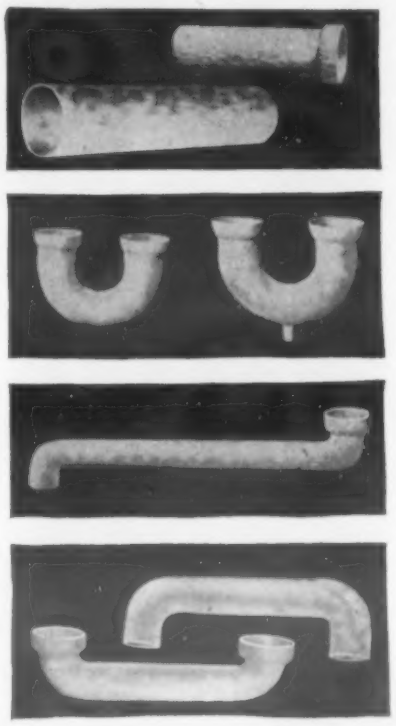

Heretofore the design and selection of silica ware units, for processes involving extreme temperatures and highly corrosive conditions, has been on the basis of fitting various pieces of equipment together.

Amersil now offers an engineering service which includes development, research, design, controlled manufacture of major silica ware units, selection and purchase of auxiliaries, all under one contract one responsibility.

Because of this integrated design and manufacturing service, Amersil is able to guarantee performance.

AMERSIL COMPANY Inc.

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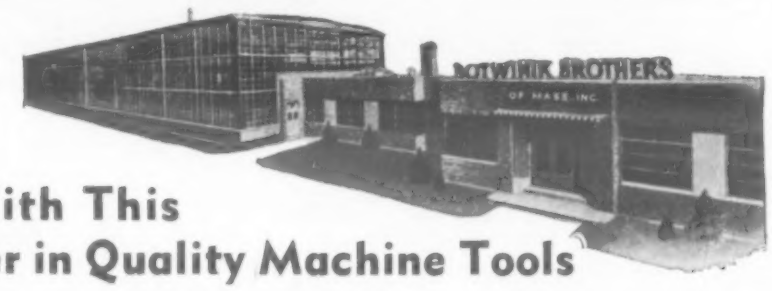

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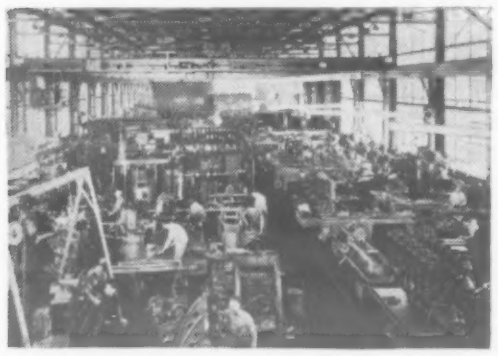

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steel and chrome-plated. The first and second standards are ball bearing equipped. A special indicator on the base indicates the vertical axis when adjusting diamond clearance. All binding screws are brass tipped for better tension and locking qualities. Tool bit slot capacities are 3/16 in., ¼ in., 5/16 in., ⅜ in. and 7/16 in.

The device is furnished complete with vise, diamond holder, 8-32 Allen wrench, ½-in. straight-shank center, and removable handle used in wheel dressing.

New Coating Protects Electroplating and Pickling Racks

A new solution for the coating of electroplating and pickling racks has been developed by the *B. F. Goodrich Co.*, Akron. The new product is known as Korolac RX-2500.

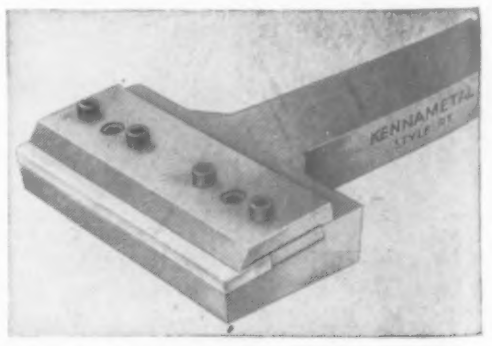
A second new development, known as Korolac Primer No. A-208-B, is used in conjunction with the above solution to provide adhesion of the coating to the metal rack. This primer is brushed onto the rack and areas adjacent to the contact points, thereby preventing contamination of plating baths by carry-over of solutions underneath the protective rack coating.

The new coating is white, opaque and glossy. Hot alcoholic reverse current cleaners and such oxidizing acids as chromic and 40% nitric have little or no effect. The resistance to organic solvent cleaners is said to be good.

New Tool for Turning Chilled Cast Iron Rolls

A line of broad-nose tools for turning cast iron rolls up to 90 Scleroscope has been developed by *Kennametal Inc.*, Latrobe, Pa. The tools comprise solid Kennametal Grade K6 blades, held in position on the surface of the supporting shank by a clamp and serrated, advanceable back-up plate.

The blade has four cutting edges that may be used in succession before any sharpening is required. Then it can be re-



This new tool for turning cast iron rolls has four cutting edges.

ground and advanced each time to cutting position, until 2/3 of the blade has been utilized.

These tools are available in four standard cutting widths: Style 4RT—4 in.; Style 6RT—6 in.; Style 8RT—8 in.; Style 10 RT—10 in.

New 9% Nickel Tubing Steel

(continued from page 67)

Since a cooling rate of 10 F per hr. is a much slower rate than is normally encountered in industrial heat treating operations, the susceptibility of 9% nickel steel to temper-embrittlement may be considered negligible for all practical purposes, especially when considered in connection with the manufacture and heat treatment of tubular products.

Heat Treatment

A series of heat treating experiments were conducted on 9% nickel steel in order to determine its hardenability characteristics, and the effect of tempering (drawing) temperatures on the softening of this steel. In addition, an attempt was made also to approximate the lower critical point (Ac_1) by the results of the tempering tests.

The results of the hardenability tests reveal that water quenching does not impart much greater hardness than air cooling from temperature. However, for the amount of carbon present (0.10% max.), 9% nickel steel shows a relatively good degree of hardenability, which is apparently due to the hardening effect imparted by nickel to ferritic steels. Fig. 3, which illustrates the hardening range of 9% nickel steel, shows that the maximum hardness of both the water quenched and air cooled specimens occurs in a range between 1400 F and 1600 F. The results of Jominy end-quench hardenability tests from 1400 F and 1600 F, Fig. 4, reveal that the steel is of the deep hardening type but has a relatively low maximum hardenability.

The tempering tests were carried out on specimens obtained from Heat No. 14324 and had an intermediate hardness between the softest and hardest of the commercial heats investigated. Table VIII, which lists the results of these tests, indicates that maximum softening is attained between 1000 F and 1100 F, with the hardness decreasing as the time at temperature is increased up to 3 hr. It is also evident that heating at 1125 F or higher produces hardening rather than softening. The hardening effect increases with time and temperature and, in this steel, it is due to the fact that the temperatures resulting in hardening are over the lower critical point (Ac) which, based on the results of the tempering tests, is somewhere between 1100 F and 1125 F. However, this is only an approximation and further, more accurate (dilatometric) tests are in progress at various heating rates to determine the exact transformation temperatures of 9% nickel steel.

Cold Working

Specimens representing cold drawn finished tubing, 2-1/32-in. O.D. by 0.134-in. wall, were flattened and flared after being normalized at 1575 F and tempered at 1075 F for 1 hr., and also after being normalized

(continued on page 160)

This time it is for The General Fireproofing Co., Youngstown, Ohio in connection with *aluminum trim* on their extensive line of office furniture of which the Super-Filer, as illustrated, is typical. A Lea Method with Lea Composition is doing an effective job, producing a fine satin finish.

Hundreds, even thousands, of metal fabricators have turned to LEA for the solution of post-war finishing problems. Many of them were pre-war as well as war-contract customers. They appreciate that Lea Technical Service and Lea Compositions lead the way to better finishes at a lower cost and speed up production.

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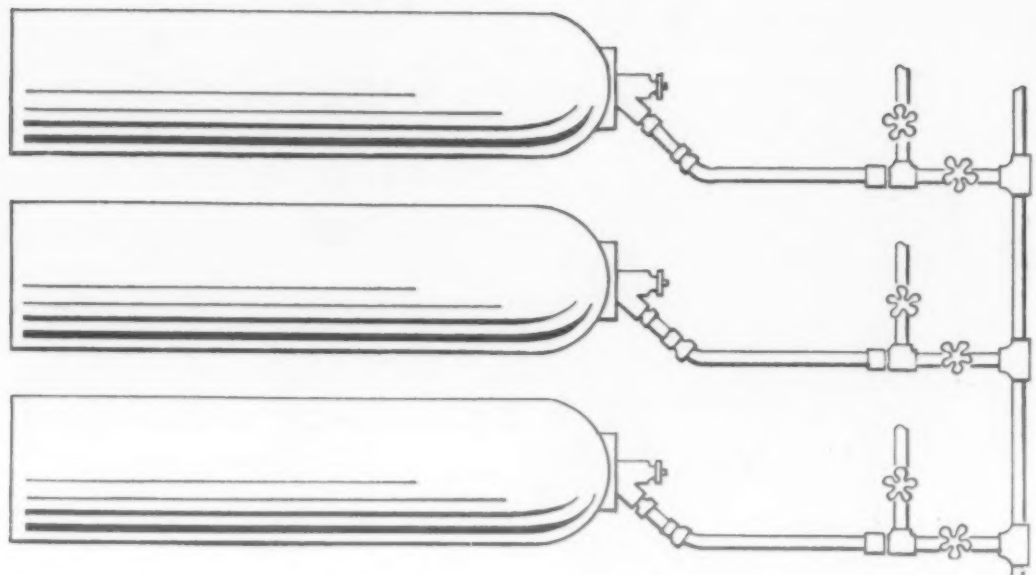

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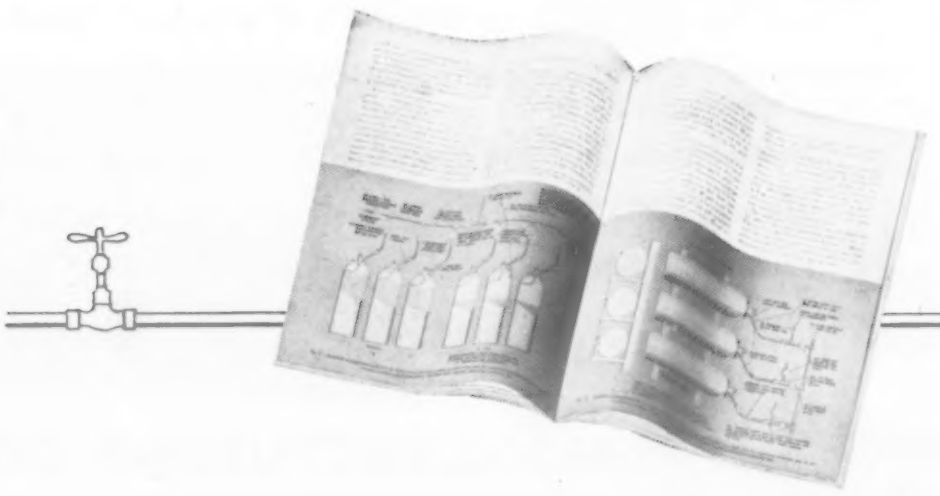

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New 9% Nickel Tubing Steel

(continued from page 159)

and tempered at 1100 F for 15 hr. Fig. 5 is a photograph depicting the results. It will be observed that the specimens flared satisfactorily and flattened to approximately one-half their original O.D. measurement in the case of both heat treatments. The inability of 9% nickel steel tubing to flatten further is due to its high strength properties. Nevertheless, tubes of this material have shown ample ductility in physical tests and in expanding experiments, as mentioned previously.

Tentative specifications prepared by us covering 9% nickel steel tubing call for flare tests only. If, in the future, these specifications also require flattening tests, due consideration should be given to the fact that tubes of this material exhibit ample ductility albeit they flatten to a lesser extent than carbon steels of lower tensile strength even when in the fully softened condition. This is simply in keeping with the intrinsic tensile characteristics of the 9% nickel steel.

Microstructure

The microstructural aspects of all the commercial heats examined to date were found to be similar. The typical structure of the as-rolled 3-in. round is shown to consist of carbides, acicular martensite and retained austenite. Normalizing, followed by reheating for 1 hr. at 1050 F brings out some banding and also results in a fine, uniform grain size. This banded structure, common to nickel and other low-alloy steels, is probably the reason for the difference in impact strength of the longitudinal and transverse impact specimens inasmuch as a structure of this type affects the directional properties of steel, with the least strength and/or toughness and ductility being shown in sections cut transversely to the direction of rolling. The effect of banding in tubing may be minimized by diffusion, as the material is further worked and heat treated. The typical structure of 2-1/32-in. O.D. by 0.134-in. wall tubing, normalized and drawn, is shown in Figs. 6 and 7.

The grain size of all the heats, as determined by the McQuaid-Ehn carburizing test, was fine with the grain size being 6-7 (5) in all cases.

Figs. 8 and 9 depict the structure of the case and core, respectively, revealing the case to be martensitic, while the core consists of carbides in a matrix of ferrite. These structures indicate that 9% nickel steel has a hard case and tough core which are the necessary criteria for a good carburizing steel. Hardness of a quenched carburized case is 57 to 59 Rockwell C. The relatively low hardness may be due to retained austenite in the structure. Temperatures of 100 to 1000 F did not effect an increase in hardness; however, further experimentation is being conducted in an attempt to raise the hardness of the case.

(continued on page 161)

New 9% Nickel Tubing Steel

(continued from page 160)

Welding Characteristics

It is generally agreed that weldability of a material is determined by its ductility in the heat affected zone. However, there has been little agreement as to exact technique which should be used for measuring ductility. Although the tensile and bend tests provide the most direct methods of evaluating ductility, a hardness survey of the heat affected zone too may serve as an index of weldability. Another alternative is a microscopic study made of the structures resulting from welding, with the suggestion that ductility may be predicted from a careful evaluation of these structures.

The weldability of 9% nickel steel tubing was investigated by means of all the methods indicated in the preceding paragraph as was, also the effect of metallurgical changes associated with welding upon the mechanical characteristics of 9% nickel steel tubing at room and sub-zero temperatures.

The test samples used for these purposes were obtained from normalized and tempered cold drawn 9% nickel steel tubing of regular commercial manufacture. Six specimens of 2-in. O.D. by 0.134-in. wall tubing were flash-butt welded and four specimens 2-1/16-in. O.D. by 0.134-in. wall thickness were metallic are welded, using 25% chromium, 20 nickel electrodes.

After welding, the flash and arc welded samples were subjected to a stress relieving treatment consisting of heating for 2 hr. at 1050 F followed by air cooling or water quenching.

The results obtained are summarized in Table IX, where also are indicated the condition of the I.D. and O.D. flash or bead, as well as the specific heat treatment to which each sample had been subjected prior to testing. Correlation of the tabulated data shows that the flash welded samples exhibited higher yield strength, comparable tensile strength and considerably higher ductility than the arc welded specimens. All but one of the arc welded specimens broke in the weld (25 chromium-20 nickel metal) whereas the flash welded samples broke away from the weld and the heat affected zone.

Bend and Impact Values for Welds

The bend ductility of the weldments was determined on longitudinal strips, with the weld in the center, measuring 1-in. wide by 10-in. long.

The results, as given in Table IX, indicate that all the flash butt welded samples bent to a full 180 deg. without cracking or other signs of distress. This was found also to be the case with the arc welded samples, except for two root bend tests which had to be discontinued after bending to approximately 120 deg. in view of transverse splits which occurred in the weld.

Sub-size (¼ size) Charpy specimens were used to determine the notch-impact

(continued on page 162)

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New 9% Nickel Tubing Steel

(continued from page 161)

toughness of the arc welded samples at room temperature and at −320 F. The specimens were either keyhole or V-notched in the weld or in the heat affected zone. All the notches were located at a plane transverse to the direction of rolling of the material.

The notched-bar test results are given in Table X. A comparison of the values obtained at room temperature and at −320 F shows a 10 to 40% decrease in impact strength at −320 F. In general, the specimens notched in the heat affected zone had somewhat greater toughness than those with the notch in the weld proper. No definite trend was exhibited by the two types of notches viz. the keyhole and V-notch.

In our work, we employed a somewhat conservative basis in estimating working values for standard size specimens, namely, the experimental values obtained in the ¼ size welded Charpy specimens were assumed to represent 40% of the strength of standard specimens. The values so calculated are given in the last column of Table X. They show notch-impact strength upwards of 20 ft.-lb. and may be considered satisfactory (see values obtained on standard size notched bars, Table VI).

As regards the effect of time at temperature, several investigators (5) have shown that prolonged holding times at sub-zero temperatures exert only negligible effect on the notch-impact toughness of nickel and austenitic welds. These findings were recently confirmed in tests conducted by The International Nickel Co., Inc. (private communication from V. N. Krivobok, October 1946) on 25 chromium-20% nickel welds on steel plate.

A Vickers (10-kg. load) hardness survey indicates that the hardness in the heat affected zone of the arc welded samples was comparable to that of the base metal and was of the order of 245 VHN. The corresponding values for the flash butt welds were approximately 30 VHN higher, but judging from the results of the mechanical tests, this hardness did not effectively impair the ductility of the weldment. The microstructure of the tubing material (normalized and tempered prior to, and heat treated at 1050 F, after welding) reveals fine grain size (ASTM 6-7) and some banding, characteristic for this material.

Suggested Applications

The 9% nickel steel described herein appears to warrant consideration for use in connection with the handling of alkaline solutions and paper mill black liquors and for circumstances where very mildly acidic conditions prevail. It also exhibits properties suitable for low temperature application in handling liquefied gases and other low temperature media.

At present, it is being tried as evaporator tubes for evaporation of caustic soda solu-

(continued on page 163)

New 9% Nickel Tubing Steel

(continued from page 162)

tions, as flow down lines on corrosive gas distillate wells, and as sucker rods in wells pumping corrosive fluids. It is being tested in connection with phenol synthesis and is being considered for parts of equipment for low temperature service. Data from service tests of such nature are in the process of being accumulated. While the mechanical properties, especially at sub-zero temperature, have been emphasized in the present article, it is believed that the major field of application for this new steel will be in corrosion resistant services in those media where nickel effects improvement in corrosion resistance.

Conclusion

The data summarized in this article permit the following more important conclusions:

1. 9% nickel steel renders itself readily adaptable to the various processes associated with the manufacture and fabrication of seamless tubing.
2. Properly manufactured (deoxidized) 9% nickel steel tubing possesses excellent mechanical properties down to −320 F.
3. For all practical purposes, 9% nickel steel tubing can be considered immune to temper embrittlement at room and sub-zero temperatures.
4. 9% nickel steel tubing possesses satisfactory weldability and does not present any undue difficulty on welding by the flash or arc welding processes.
5. The mechanical properties of butt welded seamless tubing are satisfactory at room and sub-zero temperatures (down to −320 F) and are comparable to unwelded 9% nickel steel tubing.

The authors acknowledge, with thanks, the cooperation of the Technical Dept., International Nickel Co., Inc., in aiding in the development of this new steel and Taylor-Winfield Corp., Warren, Ohio, for preparation of a number of the flash butt welds reported on herein. Thanks are due the company officials of The Babcock & Wilcox Tube Co. for permission to publish the data given herein.

Selected References on the Behavior of Ferritic Steels and Welded Joints at Sub-Atmospheric Temperatures:

Gillett, H. W. and McGuire, F. T., Behavior of Ferritic Steels at Low Temperatures, Parts I and II, ASTM, 1945.

Gillett, H. W., Impact Resistance and Tensile Properties of Metals at Sub-Atmospheric Temperatures, ASTM, 1941.

International Nickel Co., Inc., Properties of Nickel Alloy Steels at Low Temperatures, Section 5 (revised to March 1941).

Habart, H. and Herge, W. J., Sub-Size Charpy Relationships at Sub-Zero Temperatures, ASTM Preprint No. 37 (1939).

Spraragen, W., and Cordovi, M. A., Behavior of Welded Joints at Low Temperatures, *Welding Journal*, Vol. 23, Res. Suppl. No. 2, pp. 97-S to 120-S.

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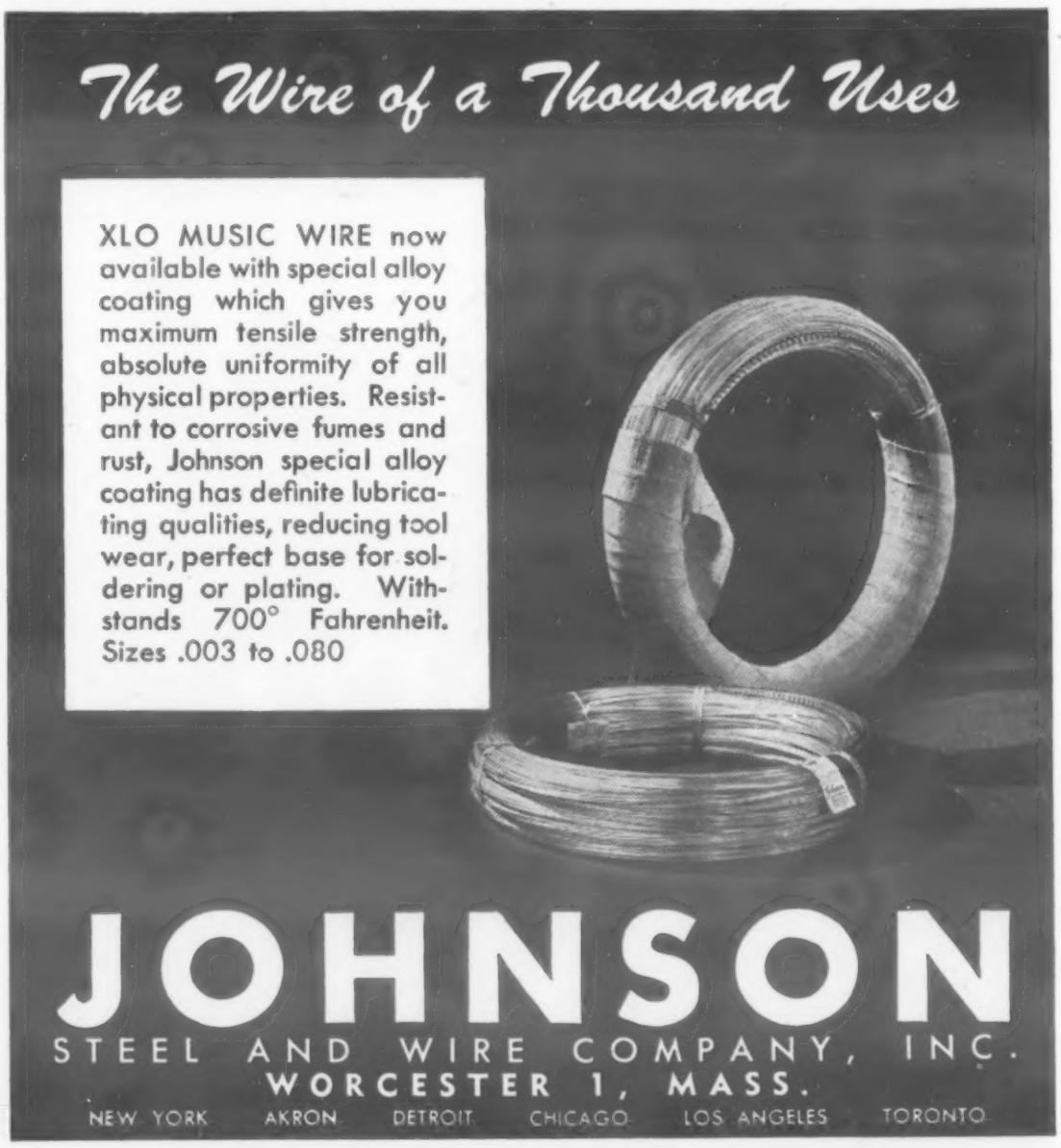
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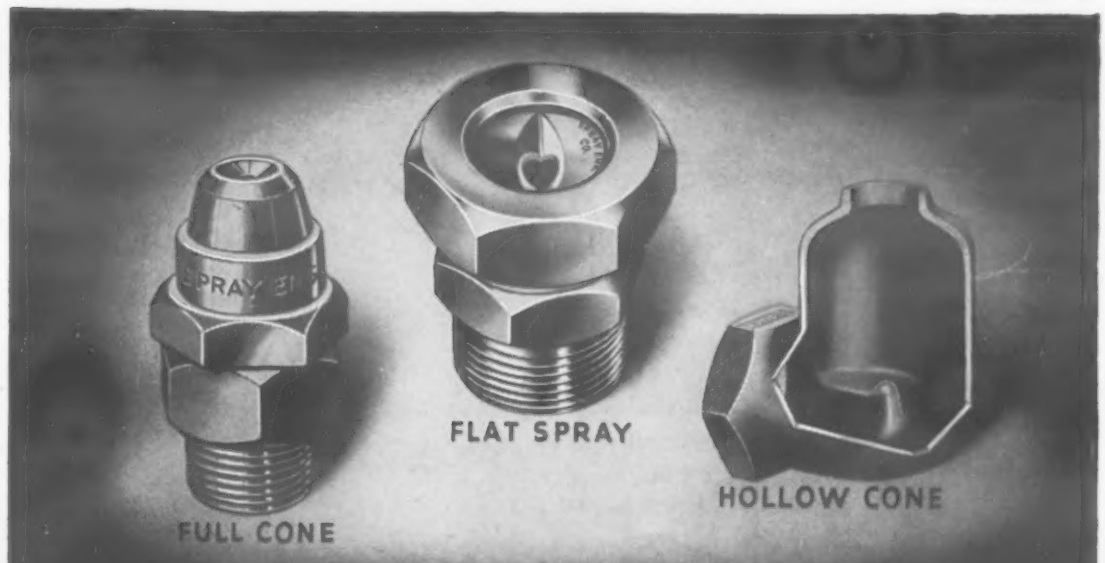

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News of...

ENGINEERS COMPANIES SOCIETIES

News of Engineers

Lee G. Miller, formerly superintendent, has been made plant manager, Lebanon Steel Foundry. He has been with the company 20 years and takes the place of *Frank J. Stanley,* resigned.

Fred A. Kaufman, formerly industrial fellow, McKay Co. fellowship at the Mellon Institute of Industrial Research, has been transferred to the McKay Co., Pittsburgh, as metallurgical engineer, where he will be in charge of technical and engineering service in the arc welding electrode division.

Otto E. Zahn, for nine years with American Wheelabrator & Equipment Corp., in industrial and development engineering capacities, has set up his own consulting service at 218 Napoleon Blvd., South Bend 17, Ind. He will cover problems in patent research and development, product engineering, industrial engineering, metallurgical research, and chemical and electrical engineering.

Theodore Voyda has become chief chemist for Apothecaries Hall Co., Waterbury, Conn., maker and distributor of industrial chemicals, plating supplies and equipment. For seven years he has been with Pratt & Whitney Aircraft Co. in charge of research and development in plating and metal processing. He is president of the Hartford chapter of the American Electrochemical Society.

Dr. W. A. Johnson, manager, metallurgical section, Westinghouse Research Laboratories, will set up and direct a new metallurgical division of the Clinton laboratories at Oak Ridge, Tenn., in connection with military and peacetime applications of atomic energy. He taught at Carnegie Tech for one year.

Gerhardt Bartz has become works manager, Bellevue Industrial Furnace

Co., Detroit 7, having left the Dodge forge division, Chrysler Corp., where he was assistant plant engineer. Previous connections were with Western Electric, Continental Motors and Paasche Air Brush Co.

Robert O. Bullard, superintendent, carbon products manufacturing division, apparatus department, General Electric Co., Pittsfield, Mass., has become engineering and manufacturing manager of the metallurgy division. He started with G.E. in 1930 as a student engineer. He became superintendent of the General Electric plant at Ft. Edward, N. Y., in 1942.

John W. Baer, three years with the Army Engineers, emerging as captain, has become chief engineer for the Forker Corp., Cleveland, maker of Ohio tramrail systems. Before joining the army he was tool engineer and chief draftsman with Forker.

Clarence H. Sample, formerly chief engineer, Rheem Research Products, Inc., has joined the electroplating section, International Nickel Co. For 15 years he was with Bell Telephone Laboratories, Inc., doing research on corrosion and metallic finishes.

Foster Dee Snell, president, Foster D. Snell, Inc., and president, American Institute of Chemists, has been elected honorary member, Chemical, Metallurgical and Mining Society of South Africa.

J. F. Simon, Jr. has become works manager, Paul & Beekman Div., at Philadelphia, Portable Products Corp., Pittsburgh, maker of stamped and drawn metal parts for general industry and radio and electronic fields. He was formerly plant manager with the Roller-Smith Co., Bethlehem, Pa.

Richard C. Gerdes has become Chicago district supervisor of production planning for American Steel & Wire Co., having been promoted from the company's Joliet works where he was works supervisor of production planning.

W. M. Donohoo, for 12 years superintendent, heat treating division, M. A. Ford Mfg. Co., Inc., Davenport, Iowa, has established his own firm, Donohoo Steel Treating Co., Bettendorf, Iowa. At one time he was heat-treating superintendent, Rock Island Arsenal, Rock Island, Ill.

James P. Gill, vice president, Vanadium-Alloys Steel Co., Latrobe, Pa., has received the honorary degree of doctor

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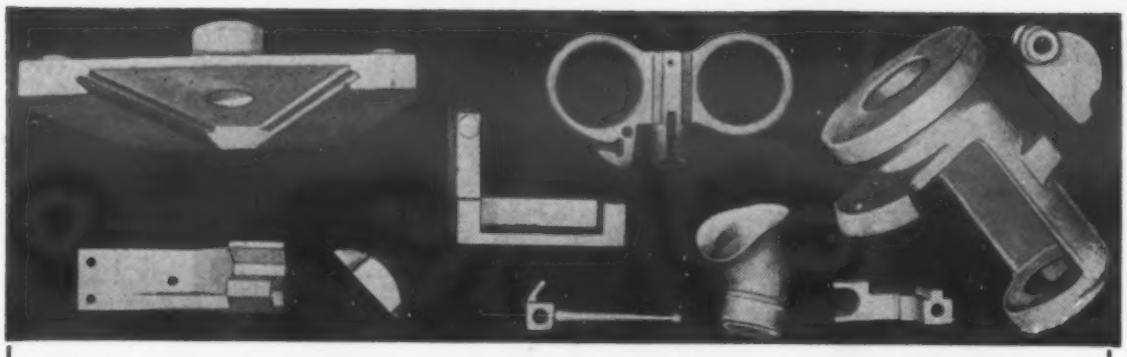

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News of

Engineers — Companies — Societies

of engineering from the University of Missouri. Mr. Gill gave the annual Campbell Memorial lecture before the American Society for Metals in 1936, and in 1939 was elected national president of ASM. He is author of books and technical papers on tool steels.

Frank L. Magee, general production manager, Aluminum Co. of America, has been made vice president. He became general production manager and assistant to the vice president in 1943.

Robert L. Crinnian has become assistant chief engineer, Pioneer Engineering & Mfg. Co., Detroit designers and engineers. He is founder and past president of the American Society of Industrial Engineers.

Companies

The name of the 38-year-old *American Foundry Equipment Co.,* Mishawaka, Ind., has been changed to *American Wheelabrator & Equipment Corp.,* the change being made to better recognize the company's chief product.

American Can Co. celebrated the opening of its enlarged research laboratory at Maywood, Ill., Nov. 20, coincident with the 40th anniversary of the founding of the research division. The company's first laboratory was established at Niagara Falls, N. Y., in 1906 to develop a process for salvaging tin from scrap.

As of Jan. 1, 1947, the *Aluminum Co. of America* has been marketing the alumina and fluoride products of *Aluminum Ore Co.,* subsidiary, under the "Alcoa" trademark, having discontinued the "Alorco" trade name.

Fischer & Porter Co., Hatboro, Pa., maker of variable area type flow metering instruments heretofore called "Rotameters", has changed to the trademark name of "Flowrator".

The *Clipper Mfg. Co.* has consolidated in part its St. Louis office with its newly completed factory and general office building at 2800 Warwick St., Kansas City 8, Mo. Its St. Louis warehouse will remain intact at 4030 Manchester St. as a permanent shipping point. Manufacturing facilities have been expanded, with complete laboratory added.

(Continued on page 169)

Earle P. Turner, Toms River, N. J., builder and manager of the *Reade Co.*, Lakehurst, N. J., producer of metal powders, has sold his partnership interest in that company to Charles H. and Leonard J. Reade.

The *Barium Steel Corp.* has acquired full control of the *Cuyahoga Spring Co.*, Cleveland, as well as of the *Bayonne Bolt Corp.*, Bayonne, N. J.

The *Westinghouse Electric Corp.* is purchasing a plant from the War Assets Administration at Vanport, Beaver County, Pa., operated during the war by the *Curtiss Wright Corp.* The Westinghouse Small De-Ion Circuit Breaker Dept. will move to this plant from East Pittsburgh, Pa.

Indar Corp., Indianapolis 5, has completed its engineering work on production of powder metallurgical parts of ferrous and nonferrous metals, including high frequency iron cores. It now has complete facilities for mixing, pressing and sintering.

The *Tool-Die Engineering Co.*, Cleveland 15, is setting up a plant at E. 93rd and Loren Ave. to make die castings of zinc and aluminum, as well as permanent mold castings. Besides production, the company will perform consultation and service. C. G. Siefert, president, has had 25 years experience in die casting.

Arcos Corp., Philadelphia, maker of electrodes and rods for welding and cutting stainless steels and alloys, has completed a new laboratory building adjoining its plant to house its research and engineering department.

Pacific Tube Co., East Los Angeles 22, the only mill of its kind West of the Rockies, has purchased Government-owned facilities operated by the company from the War Assets Administration.

H. K. Porter Co., Inc., has moved its two Quimby Pump manufacturing operations in New Jersey to Laurenceville, Pittsburgh.

Arocast Corp. and *Precise Castings Corp.* have combined their facilities in new quarters at Hillside, N. J. They are now qualified to furnish precision castings in any castable alloy.

John R. Strauss has purchased controlling interest in *N. Ransohoff, Inc.*, Cincinnati 2, maker of metal cleaning machinery.

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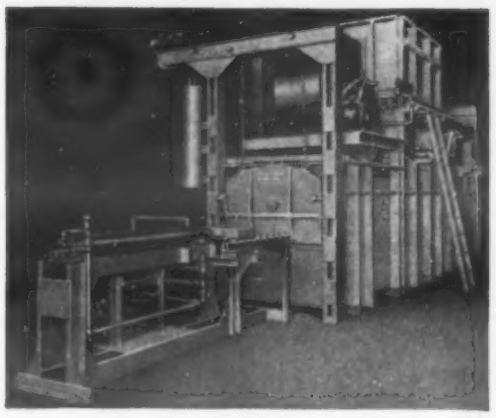

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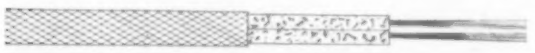

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News of

Engineers — Companies — Societies

Chicago, has opened a branch plant at 620 Buffalo Road, Rochester, N. Y.

The *Borg-Warner Corp.* has bought the physical assets of the *Superior Sheet Steel Co.*, Canton, Ohio, to increase production of sheet steel in the present housing emergency.

Societies

American engineers will participate in a permanent *World Engineering Conference*, with headquarters in Paris, and which will have a working contact with the United Nations Educational, Scientific and Cultural Organization. The following countries will be represented at the start: United States, China, Egypt, France, Great Britain, India, Poland, Switzerland and Czechoslovakia.

Clyde E. Williams, director of Battelle Memorial Institute, has been made president of the *American Institute of Mining & Metallurgical Engineers* for 1947. Two new vice-presidents are: Andrew Fletcher, vice president, St. Joseph Lead Co., and Robert W. Thomas, general manager, Nevada Consolidated Copper Corp.

For the second consecutive year a student of Illinois Institute of Technology has won the undergraduate student award of the *American Society of Mechanical Engineers*. He is Paul A. Thompson, Aurora, Ill., formerly research department, Sapphire Products Div., Elgin National Watch Co. His prize-winning paper was: "Synthetic Sapphire, A New Industrial Engineering Material".

L. A. Lindberg, president, Lindberg Steel Treating Co., Chicago, is the new president of the *Metal Treating Institute*. A feature of the institute for the coming year is publication of a book, "Manual for Heat Treating Services" to aid the buyer of such services.

A Western Metal Congress will be held at the Oakland (Cal.) Municipal Auditorium, March 22-27, under auspices of the *American Society for Metals*. According to the chairman of the program committee, Dr. John E. Dorn, Associate professor of metallurgy, University of California, "the program will cover practically every

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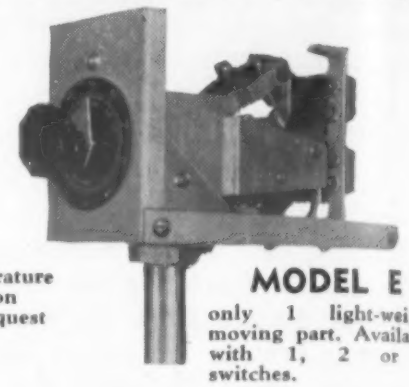

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only 1 light-weight moving part. Available with 1, 2 or 3 switches.

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- **Accurate, Rugged, Dependable**
- **Corrosion and heat resisting tube**
- **Dial Pointer for easy setting**
- **Locking screw locks temperature setting**
- **Terminal plate has large screw terminals**
- **Snap-action Micro-Switch eliminates contact troubles**
- **Increased Adjustable range to 700-1000°**
- **Dimensions—7¼" x 2¾" x 3½"**

MODEL V-I

For lower temperature range from 0-300°F. Available for minimum of —100° to maximum of 600°F. Usual adjustable range 50-150°, operating differential may be as small as ±¼ or as large as ±5°. Adjustable by screw and dial inside case. (Sizes 2¾" diameter × 4¼" high)

MODEL D

Adjustable range 200-500°F. Temperature range 0-1400°F. For use where temperature must be changed to suit operating conditions. Turn outside knob to change temperature setting. (Sizes 5½ x 2¾ x 2¾").

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phase of the manufacture, production, fabrication, inspection, testing, welding and use of metals".

Julius F. Stone, president, *Ohio State University's Research Foundation* since 1938, has been made chairman of the board. Mr. Stone, now 91 years old, is the "father of the Foundation" and has been prominently identified with Ohio State for many years.

The cupola research committee of the *American Foundrymen's Assn.* will sponsor an intensive study of foundry coke quality and behavior. Data will be gathered on fuel ratios, air volume, analysis of effluent gases, melting rates and temperatures, slag, type of metal produced, cupola construction, and the like. R. G. McElwee, Vanadium Corp. of America, is committee chairman.

Frederick R. Lack, vice president, Western Electric Co., is president of the *American Standards Assn.* for the ensuing year. During the war he was a director of the Army and Navy Electronics Production Agency.

The *American Society of Mechanical Engineers* has bestowed its highest honor on Morris Evans Leeds, 77 year old Philadelphia inventor and manufacturer of electrical and temperature measuring instruments.

Meetings and Expositions

MATERIALS HANDLING EXPOSITION, Cleveland, Ohio. Jan. 14-17, 1947.

SOCIETY OF THE PLASTICS INDUSTRY, Low-Pressure Div. meeting. Chicago, Ill. Jan. 23-26, 1947.

SOCIETY OF PLASTICS ENGINEERS, annual plastics show and convention. Chicago, Ill. Jan. 25-31, 1947.

INSTITUTE OF THE AERONAUTICAL SCIENCES, annual meeting. New York, N. Y. Jan. 27-30, 1947.

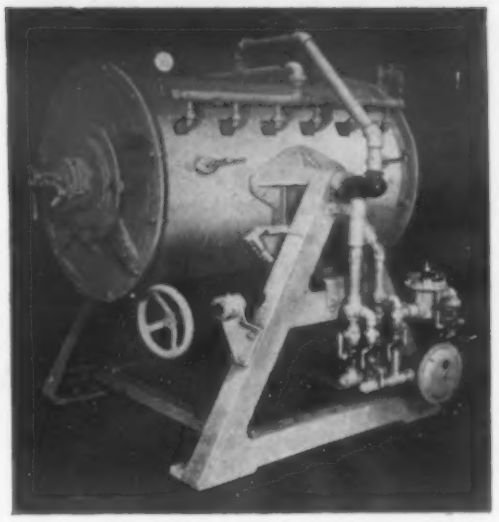
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, winter meeting. New York, N. Y. Jan. 27-31, 1947.

AMERICAN SOCIETY OF HEATING & VENTILATING ENGINEERS, annual meeting. Cleveland, Ohio. Jan. 27-31, 1947.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, annual meeting. New York, N. Y. Feb. 16-20, 1947.

AMERICAN SOCIETY FOR TESTING MATERIALS, Committee Week. Philadelphia, Pa. Feb. 24-28, 1947.

ROTARY GAS CARBURIZERS



Versatility is the outstanding characteristic of AGF Rotary Gas Carburizing Machines, which may be used not only for carburizing, but also for clean hardening, normalizing, annealing, and other general or atmospheric work without modification to the machine of any kind.

Uniform heating of the work is assured by the gentle mixing produced by the rotary action of the retort, which is heated by numerous carefully distributed and balanced gas burners. Carburizing or atmosphere gas is introduced through a simply-designed, trouble-free connection.

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AGF gas carburizing equipment also includes Continuous Rotary Machines and Vertical Retort Carburizers. Write for literature.

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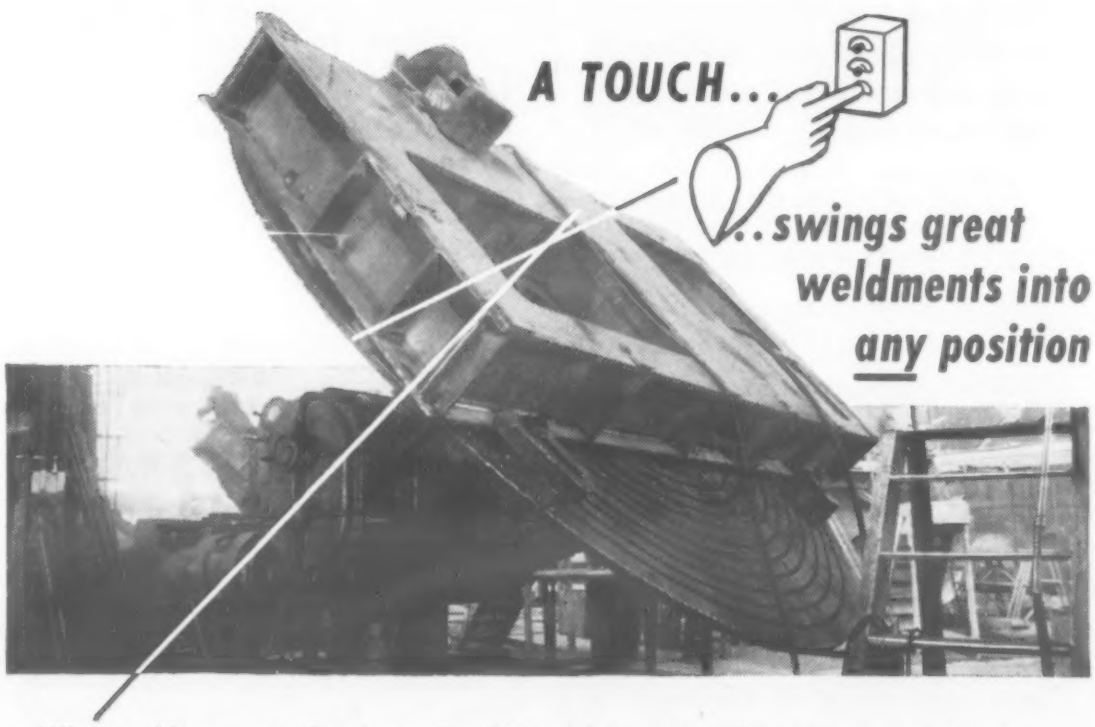

When weldors can swing tons of weldment into any position for the next downhand pass quickly and safely, with a touch on the push button control, they are able to work better, faster and more economically, no matter what the job. Interruptions in any welding operation are costly—when weldors or their helpers must prop up, flop, turn over, crawl under, over and around a weldment, they are adding costs to the job. Because more and more welding is being done in today's production, it is important that your welding costs and quality be examined in the light of economies and improvements made possible by C-F Positioners.

Not only do C-F Positioners give weldors more time for welding by permitting them to swing weldments into the correct position for a downhand pass, they make all welding better and more economical by making possible the use of heavier electrodes, eliminate "overwelding" and waste of power and materials. Write for Bulletin WP 22. CULLEN-FRIESTEDT CO., 1314 S. Kilbourn Ave., Chicago 23, Ill.

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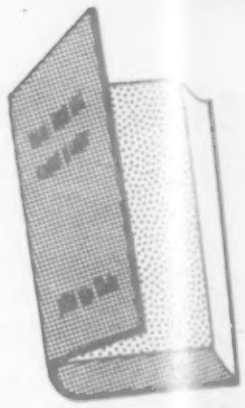
BOOK REVIEWS



Cobalt

COBALT. *By Robert Perrault. Published by Dunod, Paris, 1946. Paper bound, 6 x 9 in., 160 pages. Price 390 fr.*

This little book (written in French) by a French mining engineer is introduced with a preface by M. Pierre Chevenard. The first chapter, as is customary, is devoted to a history of cobalt, its early uses and users. The natural forms in which cobalt is found and their identification are the topics treated in the second chapter. Chapter 3 is a brief summary of the deposits of cobalt bearing minerals in the various parts of the world. Next (Chapter 4) comes some discussions of the methods of obtaining cobalt from these ores and then, the chemical, physical, and physiological properties and qualities of cobalt are cataloged in Chapter 5.

The eight most important uses of cobalt are listed in Chapter 6 as (1) in high-speed steels, (2) in magnet steels, (3) special steels, such as for exhaust valves, (4) miscellaneous alloys, such as stellite and iron-nickel-cobalt, etc., (5) carbides, (6) as catalytic agents (especially those used in the manufacture of synthetic oils and perfumes), (7) as electro-plated coatings, and (8) its uses in the form of oxides and salts are considered at some length. Thus, chapter 6 is a rather concise and up-to-the-minute survey of the major uses of this important metal. Some economics data are included in the last chapter.

This book is an interesting summary of French usage and of war developments in the utilization of cobalt in a wide variety of industries; and it contains a fairly complete bibliography on the subject.

—R. S. BURPO, JR.

Careers in Aluminum

THE ALUMINUM INDUSTRY. *By Stanley V. Malcuit. Published by Bellman Publishing Co., Inc., Boston, 1946. Heavy paper, 6 x 9 in., 36 pages. Price $1.00.*

This is No. 4 in a list of American Industry Monographs, to eventually cover 75 basic American industries, with specialized information about the "jobs" that comprise these industries. The series is designed for guidance and rehabilitation activities. Each book supposedly presents personal qualifications required for engaging in the work, scholastic training needed, complete analysis of employment opportunities, remunerations received, chances for advancement, statement of advantages and disadvantages, and possibilities for women as well as men.

A feature of this aluminum industry book is the analytical index of occupations, comprising: automatic screw machine operator, chief clerk, continuous mill operator, drill operator, electrician, extrusion press operator, foreman, hammer operator, machinist, metallurgical engineer, molder, potman, sales engineer, secretary, superintendent and toolmaker.

Besides the more specific facts in the field of this pamphlet, there is considerable compressed background material, such as history of aluminum, chief processes, and common applications. An interesting feature is a list of technical publications that treat with aluminum.

—H. A. KNIGHT

Zinc and Its Alloys

ZINC AND ITS ALLOYS. (LE ZINC ET SES ALLIAGES.) *R. Grunberg, M. Maréchal, H. Patin & E. Wagner. Published by Dunod, Paris, 1946. Heavy paper, 6½ x 9½ in., 236 pages. Price 500 fr.*

The chapters deal with smelting, characteristics and uses of the metal, rolled zinc, other uses of the metal (hot dipping, metal spray, powder), generalizations on alloys (equilibrium diagrams, commercial alloys), gravity casting, pressure casting, intermediate products (bars, wire, tubing, sheet and strips), welding and brazing, corrosion, and analysis.

Little is included that is not available in English. A large proportion of the information is taken from pamphlets of the N. J. Zinc Co. The main virtue of the book is the bringing together, between one pair of (paper) covers, material available in scattered form.

There is no index. The poor paper and flimsy paper binding would not stand much handling. The American reader might as well get a set of the N. J. Zinc pamphlets.

—H. W. GILLETT

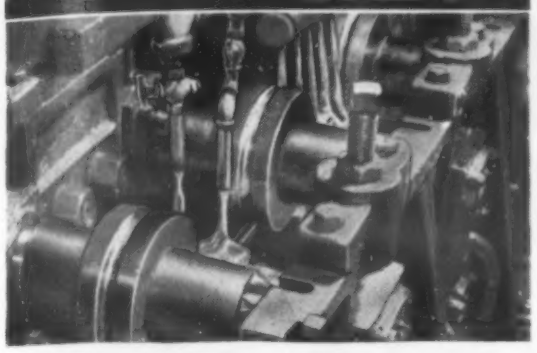
Carbon

INDUSTRIAL CARBON—SECOND EDITION. *By C. L. Mantell. Published by D. Van Nostrand Co., Inc., New York, 1946. Cloth, 6¼ x 9¼ in., 472 pages. Price $7.50.*

The author of this book, a well-known consulting metallurgical engineer, states that this second edition represents a complete rewriting of the first edition, published in 1928. This has been necessitated by the fact that there have been so many changes in the industrial progress and so

(Continued on page 173)

Guard Against T.B.*



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many increases in the applications of carbon in the intervening years.

As in the first edition, there are four major portions of the book: Elemental Forms, Adsorbents, Manufactures, and Analyses and Properties. A more comprehensive treatment of the entire subject has been attempted than was previously possible.

The first major portion — Elemental Forms—discusses the diamond, natural graphite, carbon black, lamp black, pigments, etc. Wood Carbonization and Charcoal, a chapter in the first edition, has been omitted. The second major portion covers Adsorptive Forms, which have increased "enormously in two decades." In the third portion—Manufactured Forms—there is included artificial graphite, electrodes, brushes, resistors and many other products. In the fourth and concluding portion there has been gathered together the analytical and testing methods applied to all forms of carbon with the properties tabulated and coordinated. Helpful references are distributed throughout the book.

The volume is a valuable contribution to the literature of this versatile material.

—E. F. CONE

Other New Books

TRANSACTIONS OF AMERICAN SOCIETY FOR METALS, VOL. 36. *Published by American Society for Metals, Cleveland, Ohio, 1946. Paper, 6 x 9 in., 571 pages. Free to members.* This volume contains an account of the 27th annual convention of the A.S.M., held in Cleveland, Ohio, Feb. 4 to 8, 1946. It is published both as a record and for the benefit of members who were not able to attend. Programs of technical sessions, round table discussions, and educational lectures are included in full, together with the reports of officers for 1945. The Campbell Memorial Lecture, by Dr. Maxwell Gensamer, is featured, as are also some 15 technical papers with full discussions.

COLLECTED ABSTRACTS, PUBLISHED DURING 1945 ON SPECTROCHEMICAL ANALYSIS. *Published by Ohio Valley Spectrographic Society, Engineers Club Bldg., Dayton, Ohio, 1946. Heavy paper, 6 x 9 in., 57 pages. Price $1.25.* Verbatim copies of all the abstracts published during 1945 by *Chemical Abstracts,* covering articles on spectrochemical analysis, are contained in this booklet. There are over 80 references cited, which cover all the latest reported developments in the science including analysis of alloys, direct reading instruments and other progress. The pamphlet is arranged according to topics, and is well indexed.

STANDARD METAL DIRECTORY — 10TH EDITION. *Published by Atlas Publishing Co., New York, 1946. Cloth, 5¼ x 8¼ in., 852 pages. Price $10.00.* The last edition of this Directory appeared in 1943. This 10th edition has been revised and all information and data have been brought up-to-date. The four main sections—Iron and Steel Plants; Foundries (Ferrous and Nonferrous); Metal Rolling Mills; and Metal Smelters and Refiners—contain reports on more than 7,000 companies in the United States and Canada, and are arranged in geographical and alphabetical order. Special lists of manufacturers and distributors of pig iron, ores and alloys; fabricators of structural steel, bars, sheets, tanks, plates and boilers; airplane manufacturers; merchants who specialize in used structural steel products; smelters and refiners of new and old metals; storage battery manufacturers; solder manufacturers; sheet metal stamping works; galvanizers; die casting plants; secondary metal smelters; railroad purchasing agents; copper, lead and zinc brands; scrap iron and scrap metal dealers are also included. This is a valuable reference for the steel and metal industries.

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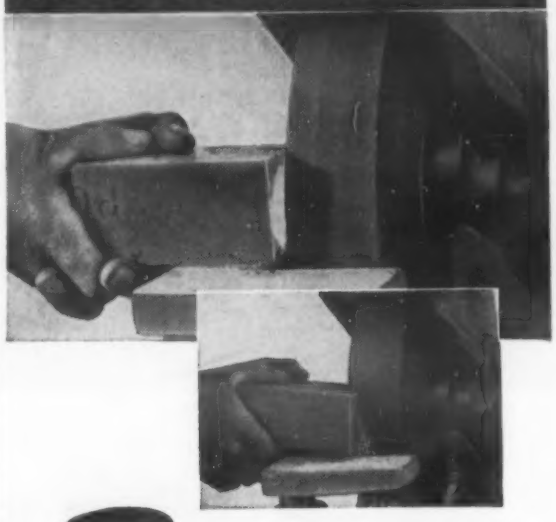

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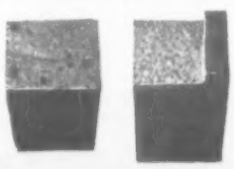

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Weirton Steel Co. 167
Agency—Campbell-Ewald Co.

Wheelco Instruments Co. 48
Agency—Don Proctor

Wiegand, Edwin L., Co. 29
Agency—Smith, Taylor & Jenkins, Inc.

Wilson Mechanical Instrument Co., Inc. 234
Agency—Reincke, Meyer & Finn, Inc.

Worcester Pressed Steel Co. 188
Agency—Sutherland-Abbott

Wyman-Gordon Co. 38
Agency—John W. Odlin Co., Inc.

Young Brothers Co. 44
Agency—Witte & Burden

Youngstown Sheet and Tube Co. 178
Agency—Griswold-Eshleman Co.

The Last WORD

by T. C. DU MOND

With the smile of supreme confidence and the wobbly legs of an infant taking his first steps, the writer assumes the role of commentator on behalf of the staff of MATERIALS & METHODS through this page which is hereby launched by the nervous tapping of fingers on the trusty portable typewriter. "The Last Word" as a department has no lofty goal other than to try to establish a common meeting place for the editors and their friends, the readers. Here we will comment on the people and things which go into the making of a technical magazine, remark—not too seriously—on events and developments which are of interest, and otherwise try always to be entertaining and occasionally educational.

What Price Materials

Now that we have introduced ourselves, may we call your attention to our new blood brother making his debut on page 8 of this issue. We predict for our new baby, "The Materials Outlook," a long and useful life devoted to keeping the MATERIALS & METHODS audience informed as to what conditions are likely to be a few months hence as to engineering materials, their prices, availability and uses. Many readers have indicated a need for information that attempts to interpret changes in the materials picture, rather than report day-to-day and week-to-week price quotations.

Editors Also Talk

If the wives of some of our editors wonder why their spouses are unlimbering their favorite oratorical gestures these wintery days, here's the answer: The winter speaking season is on full blast. Currently this department's custodian is scheduled to speak before the Pressed Metal Institute meeting in Toledo this month, while Harold Knight, who doubles in brass as our editor of matters economic, will journey to Iowa, his native state, to address a state-wide meeting in February. The chicken and peas taste just as good as ever.

To See Ourselves

Recently about 1,000 of our readers took advantage of a limited offer to tell us what they thought of our efforts. It is a source of considerable pride to know that a good majority of this group were pretty well satisfied with MATERIALS & METHODS. However, we didn't try to find what was liked about us nearly as much as we did seek to learn how we could improve. Changes, many of them obvious and others subtle, are now being made so we can more nearly follow the course set for us by the paying guests.

There's Magic in a Name

Advertising copywriters, bless 'em, must be hard put at times to find something catchy with which to draw customers into the stores. Perhaps that is why they sometimes glance through technical literature to find some words that are new and different—to them. "Anodized" is the latest word to be given a public workout. "They're Anodized" the ad screams in describing some men's jewelry. Nowhere does the ad in question tell what anodizing is or what favorable characteristic it imparts, but the magic of the word is supposed to make Joe Zilch run to his favorite store and gasp: "Gimmee a pair of them there super-duper anodized cuff-links."

Awards for Achievement

Rare indeed is the reader who has had our issue of last November pass his desk that is not aware that we recently concluded, successfully, the first annual MATERIALS & METHODS Achievement Award Competition. May we close the books on 1946's competition with the report that the award presentation dinner in Atlantic City during the Metal Show was a just and fitting ceremony. Mr. Almen wore his laurels gracefully. If you have not already done so, look for the announcement of the theme, rules and conditions for the 1947 competition, which appear elsewhere in this issue. Don't delay, rush right out and get yourself a large, economy size achievement and enter it immediately.

High Temperature Alloys

One sometimes wonders just how far we can go in the matter of heat resisting alloys. It seems like an endless circle now that military scientists are predicting that the next war (Heaven forbid) will be fought with bullets of molten metal. First an alloy must be developed that will retain some semblance of shape even though molten, then we will need another alloy that will resist penetration of this hot shot, and another to confine the first until it is released.

Shoelaces and the Materials Problem

Little do we think when we tie our shoelaces in the morning that the ever-changing materials outlook would concern such lowly, but admittedly important, objects as shoelaces. But just stop to think. A few years ago we came to accept metal-tipped laces as the ultimate in service, utility and endurance. A recent Jack Benny broadcast brought the point home sharply. Shoe and department store clerks can now be driven crazy by the changeable minds of shoppers who must weigh the many pros and cons of laces tipped with metal or plastic or rubber before spending their nickels. Ah, for the days when all our problems were little ones!

Streamlined Digests

As many of you have certainly noticed by this time, our Digest department has taken on an entirely new character, starting with this issue. It is now a shorter section, more economical of your time, more selective as to content. Henceforth, the Digests will concentrate on condensations of articles from journals not readily available to most of our readers—from foreign magazines and domestic publications of limited circulation. Also, emphasis will be on new developments and new ideas, initially appearing in the articles digested, and rehashing of rehashes will be strictly outlawed. We believe the department will gain in stature through this move, even though it shrinks in girth. The change will also permit M & M editors to devote more space, time and travel to some of those features (*e.g.* Manuals and major articles) which you readers have rated highest in value.

FINIS